Electrical World and Engineer

THE CONSOLIDATION OF "THE ELECTRICAL WORLD" AND "ELECTRICAL ENGINEER."

VOL. XLIII. NEW YORK, SATURDAY, JANUARY 9, 1904. No. 2.

ELECTRICAL WORLD AND ENGINEER

Published weekly by the

McGRAW PUBLISHING CO.

114 LIBERTY STREET, NEW YORK.

TELEPHONE CALL: 7605 CORTLANDT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

EDITED BY T. C. MARTIN AND W. D. WEAVER.

CHICAGO OFFICE - - - - - - 1139 Monadnock Block.
PHILADELPHIA OFFICE - - - - - - 929 Chestnut Street.
EUROPEAN OFFICE, Hastings House, Norfolk St., Strand, London, Eng.

NOTICE TO READERS
WHO ARE NOT SUBSCRIBERS.

ELECTRICAL WORLD AND ENGINEER is not returnable from the newsdealer. If you desire to purchase the paper from a dealer it will be to your advantage to notify him that you will want it, in order to insure his having a copy for you, If you wish to receive the paper regularly, please send in your subscription so that we can mail it to you direct.

Single copies are 10 cents each. The 52 copies for the entire year cost $3.00 in advance. Please send remittance with your subscription order.

ELECTRICAL WORLD AND ENGINEER.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of ELECTRICAL WORLD AND ENGINEER by 10 A. M. MONDAY of the week of issue. New advertisements can be received up to noon of Tuesday of the week of issue.

The first issue of each month is an export issue, having an extraordinarily large foreign circulation in addition to the regular domestic and foreign circulation of this paper.

TERMS OF SUBSCRIPTION.

United States, Canada or Mexico	Per year, $3.00
Foreign Countries, within the Postal Union	6.00
Great Britain and Ireland	25 shillings
Germany	25 marks
France	31 francs
Single copies	.10

Remittances for foreign subscriptions may be made through our European office. In requesting your address changed give OLD as well as new address.

Copyright, 1904, by McGRAW PUBLISHING CO.

Entered as second-class mail matter at the New York Post Office.

NEW YORK, SATURDAY, JANUARY 9, 1904.

CONTENTS.

Editorial 73
The Joint Engineering Building Plan 76
An Edison Medal for the Institute 76
A Combined Steam and Water Power Central Station at Richmond 77
The Government Printing Office—The Electrical Equipment of the Largest Printing Office in the World—II 80
Annual Meeting of the American Association for the Advancement of Science 88
Gas Power for Central Stations 90
Telephone Transmitters—IV. By Arthur V. Abbott, C. E. 94
New Telephone Patents 96
The Design of Motor Starting Rheostats. By Arthur H. Ford, E. E. 97
The Adoption of Direct-Current Traction on the New York Central Railroad System 98
Recent Electrochemical Developments 99
Current News and Notes 99
LETTERS TO THE EDITORS:
Motor Drive in Railway Shops. By C. H. Hines 100
What is Not New in Peat Treatment. By George W. Colles 100
Digest of Current Electrical Literature 101
New Books 105
Record Run of Electric Automobile 105
New Types of Voltage Regulators for Generators 106
Reverse Current Circuit Breakers for Protection of Generators in Parallel 107
British Single-Phase Motor 108
Motor-Driven Cold Metal Saw 108
Test in Wireless Telegraphy 108
News of the Week 109

THE IROQUOIS THEATRE FIRE.

Last week at the new Iroquois Theatre in Chicago some six hundred lives were lost through what would appear to be criminal carelessness and negligence on the part of those entrusted with the management of that place. The fire which broke out on the stage in the middle of an afternoon performance and swept suddenly through the house, is now under investigation, and we must await the results before attempting to distribute blame. On the face of it, however, there are many obvious points that deserve comment. One of these touches the wild recklessness with which electric lights appear to have been used around the stage. It has been alleged and has not so far been contradicted that one of the pieces of scenery was set on fire on account of the close proximity of a sputtering, unshielded arc lamp which was used for scenic purposes, while it is also stated that an incandescent lamp projector hindered the asbestos curtain from falling its full length to the floor of the stage. We trust these points will be fully cleared up. There is no medium so safe and convenient as electricity for light and power, especially around the stage, yet there is none which is so abused and trifled with. One result of the awful disaster in Chicago has been to close up half the places of amusement as unsafe, and we are heartily glad of it. In spite of all that is said to the contrary, just as sweeping an edict ought to be and could be put in force in New York City. Meantime it is a matter of congratulation that the authorities have ordered an examination of all the electric lighting appliances and facilities in the New York theatres. We trust that the examination will be as rigid and severe as the highest standards of the art can make it, and there is no reason why this inquisition should be limited to New York City.

GAS IN SECOND PLACE.

The public is accustomed to think of gas as still the leading illuminant, but while this is probably true in Europe, in the United States the sceptre of light has definitely passed to electricity. The figures just issued by our Census Office are, indeed, startling. Gas had nearly 75 years' start over its competitor, but it now appears to be decidedly in second place. Yet there is no denying the fact that the introduction of the brilliant electric light has stimulated greatly the use of gas. There are now close upon 4,000 electric light central stations in America, but by the census of 1900 there were then only 877 gas plants, and the number was not growing perceptibly. The gas plants were earning an income of $75,000,000. Last year the central stations earned $85,000,000. The cost of construction and equipment of both was over $500,000,000. Gas employed 22,400 men and electric light 23,300.

But this is only half the story. It is estimated that there are over 50,000 isolated electric light plants in this country, and that they represent as many lamps as do the central stations. New York City has 1,000 of them, and some, like that in the Waldorf-Astoria, would run many an ambitious Western city. Hence, the figures against gas are doubled in most respects. The 20,000,000 incandescent lamps burning nightly become 40,000,000. The 400,000 arc lamps—Shelley's "insistent sisters of the day"—become 800,000. Were it not for the universal use of the gas stove and the prevalence of the gas engine, one marvels what would have become of the illuminant of our fathers.

Such is the pace at which we live to-day that, while millions of people in this country have not yet got up to the stage of "civilization"

represented by the use of gas, but when they encounter it casually employ it suicidally, other millions have outgrown and discarded it, and will have none of it even for a curling iron or a chafing dish, let alone for lighting. To put it briefly, the use of electricity for lighting in New York State alone has increased over 2,000 per cent. in ten years, and the use of electricity for power, also from central stations, has increased in the decade nearly 1,200 per cent. And yet the electricians are inclined to think they have only just started in.

ALTERNATING CURRENT LOCOMOTIVES.

Through what might seem a curious chance, during the past few months several important papers have been read by American electrical engineers before the Canadian Society of Civil Engineers. Why such a body should have been chosen instead of the American Institute of Electrical Engineers as a medium of communication with the electrical engineering profession it is difficult to fathom, particularly since in two instances the communications were the first announcements of radical departures in engineering policy on the part of American electrical manufacturing companies. This recalls a similar instance of some months ago, when one of the most important engineering announcements of several years formed the subject of a paper read before a learned body more interested in a happening of the paleozoic age or a new nebular hypothesis than in such a utilitarian matter as a modern engineering advance like the the steam turbine. Can it be that, for some occult reason, the practice of theatre folks in avoiding urban publicity upon the trial performance of a play is extending to the technical field? A reprint of one of these Canadian papers, read November 19, has just come to hand, the subject being "Some Possibilities of the Alternating-Current, Single-Phase Railway Motor," and the author, Mr. A. H. Armstrong. In the opening paragraphs of his paper Mr. Armstrong pronounces strongly in favor of the new departure in electric traction indicated by the development recently of single-phase alternating-current motors, which he says have a speed torque characteristic even better adapted for railway work than that of the direct-current series motor and, furthermore, providing ample starting torque with any voltage variation liable to occur in practical railway operation. He adds that as these motors can be operated with the single trolley and ground return and, moreover, can be operated satisfactorily on either direct or alternating current, their field of usefulness is much greater than that of their direct-current series motor competitor. He considers that this type of motor enables us to break away from the exclusive field of electric traction with frequent service and small units, and to render possible the operation of freight and passenger trains over regular steam lines.

The paper proceeds to make a comparison in detail between steam and alternating-current locomotive traction with reference to train weights of 250, 500, 1,000 and 2,000 tons, at speeds up to a maximum of 60 to 70 miles an hour. All of the steam data are based as far as possible upon actual locomotive performance sheets; the electrical data relating to the generating station are derived from present generating station practice, which, it is stated, would be merely duplicated in railway practice. The standard electrical apparatus and voltages met with in present everyday practice are only considered, and the results thus do not represent what electrical engineers may confidently expect to be able to do some time even in the near future. The conclusions are that for very infrequent service—that is, five trains per day each way or less—it would hardly pay to equip present steam roads electrically. With more frequent service, however, the saving in electrical operation becomes more marked until at from 15 to 20 trains per day each way the interest earning power of the electrical investment becomes significant. Taking into account, however, that the electrically-equipped road while carrying heavy through freight traffic with an earning capacity of from 4 to 7 per cent. on the investment, can also build up a local traffic, both freight and passenger, with practically no additional cost and showing very large returns, the balance is still more in favor of the electric locomotive. After discussing incidental savings which may be made with the electric system, and which were not taken into consideration in the preceding calculations, the final conclusion of the author is that should all the factors entering into the engineering expense of operating roads by steam and by electric locomotives be carefully considered, the possibilities opened up by the use of alternating-current motors are sufficiently great to warrant its replacing the steam locomotive in many of our railway systems, either in part or for the complete system. As this opinion may be taken to reflect the present policy of one of the great electrical manufacturing companies, which company until quite recently was—if we are to judge by the attitude of members of its technical staff in discussions on the subject—committed against alternating-current traction, the revolutionary change that in the past few months has taken place with respect to the electric traction situation is sharply defined.

MEASUREMENT OF CURRENT BY COPPER COULOMBMETER.

A matter of considerable interest is the relative value of the two fundamental methods now in use for calibrating standard voltmeters and ammeters. The first method is to use a voltameter, which, by the way, is an unfortunate term, since it resembles "voltmeter" so closely, and the term coulombmeter has consequently been wisely suggested as a convenient substitute. The second method is to use a standard cell. The first method involves the measurement of electric quantity, and thence, with the aid of elapsed time, the mean electric current strength. This measured current strength will serve to calibrate a standard ammeter directly, and will also serve to calibrate a standard voltmeter indirectly, by passing the measured current through a coil of known resistance. The second method involves the comparison of a convenient uniform e.m.f. with the e.m.f. of a Clark cell, through the medium of a potentiometer or equivalent device. In this manner a standard voltmeter may be calibrated directly, while a standard ammeter may be calibrated indirectly, by passing a current from the measured e.m.f. through the ammeter and a standard coil of known resistance.

For the purposes of commercial accuracy, either of these two methods is available. So soon, however, as the highest laboratory standard of accuracy is desired, difference of opinion is encountered as to the relative advantages of the two methods. There are potentiometer advocates, and there are coulombmeter advocates. It is interesting to observe that both methods are similar, in being fundamentally electrolytic. One, however, employs the electrolytic plating bath, while the other employs the electrolytic cell or couple. The theoretical value of the silver or copper coulombmeter method is in the Faraday law which declares that a definite quantity of metal must be removed from the anode and deposited on the cathode, for every unit quantity of electricity passing through the plating bath. The theoretical claim of the potentiometer method is that with the commercialy attainable degree to chemical purity in the substances employed, Clark cells can be reduplicated to a very satisfactory degree of accuracy in e.m.f.

The disadvantage, or weak point of the coulombmeter method is that although in strict theory the anode loses as much metal as the cathode gains, yet in practice there is always an appreciable difference between the loss of the anode and the gain of the cathode. This

difference is apparently attributable to secondary chemical actions at the anode and cathode surfaces; but whatever the explanation may be, the discrepancy introduces a certain small element of uncertainty, and it is generally admitted that the same quantity of electricity in coulombs will not produce exactly the same apparent transfer of metal when the quantity is transferred during an hour, as when transferred during a week. The disadvantage or weak point of the potentiometer method is that it is less direct than the coulombmeter method, since the coulombmeter, with a stop-watch and a chemical balance, can give a result that immediately yields the value of a certain reading on an ammeter scale; whereas the potentiometer method involves not only the error of the Clark cell, but also the error of the potentiometer. Moreover, Clark cells may not agree very closely, unless the method of setting them up be uniform, even when pure chemicals are employed; since if the mercurious sulphate solution is saturated or unsaturated makes an appreciable difference in the value of the e.m.f. at a given temperature, as well as in the temperature coefficient of variation in e.m.f.

We are inclined to the belief that if Clark cells or cadmium cells are made up according to uniform and standard specifications, their e.m.f. can be depended upon to within a very small range of variation or error, say 1/30 of one per cent., and that the error of potentiometer comparison can, with sufficient care, be made negligibly small. Consequently, standard voltmeter calibrations by the potentiometer method may be carried with reasonable care to about 1/13 of one per cent. On the other hand, differences in the making up of Clark cells may involve variations in voltmeter calibration of as much as ⅙ of one per cent. in practice. This is about as great a variation as may be found in coulombmeter measurements. Consequently, one method is about as good as the other if no special precautions are taken in regard to the standard cell. If, however, the Clark or cadmium cell can be brought by suitable international specifications to the smallest range of variation of which it is reasonably capable, then we think the potentiometer method will be found superior. At the present time many of our standard instruments in laboratory use are calibrated by the coulombmeter, and many are also calibrated by potentiometer. In many practical cases the limits of desired accuracy are such that either method is equally suitable regardless of the absolute superiority of one or the other.

THE PROGRESS OF ELECTROTECHNICAL EDUCATION.

The condition of electrotechnical education in the United States at the present time is very satisfactory. The ideal condition of technical education is that it should be open to all comers and to every citizen. It should not be stereotyped and forced into any one or two sharply defined forms, but should be multiplied and varied in degree, in time, in expectation and in cost, so that all localities, pursuits, qualifications and purses may be suited. There is no royal road to learning, and there should be built no artificial causeway. The sole conditions on which knowledge and proficiency of any kind are to be had are attention and time; or what is equivalent, effort and perseverence. These will win everywhere, and at all times, so that it is only of importance to throw facility into the line of endeavor. To the artisan belongs the night school, since his daily work forbids him to give attention except at night. The manual training school is open to the young mechanic, with limited means and time for education. The correspondence school is specially adapted to those who, remote from cities, or occupied during educational hours, can devote time to what the teacher and the mail-carrier may provide. All these do very important work for the many. To the favored few are open the higher branches of technical education offered by technical colleges. These are most costly both in time and in money. They represent an investment made by the student in education as vested capital, upon which interest returns are demanded throughout subsequent working life.

No education can expect to flourish in this age, which does not pay as well as interest. We all desire the purely ornamental, but we want only such an amount as shall adorn the stern creations of necessity and use. A few grammes of gold will gild a large mass of less valuable structural material. On the other hand, the education should not only be graded to the student, but the student to the education. The college training may be thrown away upon a student who does not possess technological aptitude. An engineer must be born as well as made. No amount of education can make up for inherent defects in vitality, temperament or specialized mental capacity. There are some students who will learn much in a manual training school and but little from a technical college. The main effort should be to increase each individual's usefulness to the utmost that local conditions will permit. Work and acquisition of some kind should be the rule for all, and the most work, the highest kind of teaching, for the few who can afford and can avail themselves of the greatest development.

In the development of our industrial resources the time has gone by when lesser proficiency will meet requirements. At this time each factory and workshop is virtually in competition with the rest of the world, and only the fitted can survive. Consequently, while empirical methods and the guidance of experience were adequate to technical prominence only a few decades ago, now they are insufficient, and the best scientific equipment must be added to experience in order successfully to cope with the engineering problems of the day. For this reason we see the technical college graduate of the best ability and best training assuming the positions of responsibility, not only in the productive and constructive departments of modern industry, but also beginning to dominate in the administrative and commercial branches. The very best material, brains and training are only just good enough for the purpose of the day. They would be relegated to a second place if yet better vitality, brains, knowledge, training and experience could be obtained. Every year must see more demand for highly specialized students of the best technical training, and the best positions will naturally tend to the possession of those who, other things being equal, have had the best education and training.

At the same time it must be remembered that the great bulk of the people employed in electrotechnical industry, the rank and file of those who produce and who apply, must continue to receive their training, so far as it can be provided outside of the school of practical experience, in the night school, or high school, or correspondence school. In the nature of things many men will attain technical prominence who have never enjoyed the advantages of special training, laboratory teaching, or technical colleges. Such men advance by right and reason of special born abilities. But because one man in the million is a genius as a painter, and becomes eminent as an untaught artist, is no reason why painting should not be regularly taught in special schools, but rather the reverse. The numerous and varied facilities for acquiring technological education in America at this time, as well as the evident endeavor of all classes to improve their education throughout life, is the most encouraging symptom, and progressive evidence of, Western civilization.

The Joint Engineering Building Plan.

With regard to the work of the committee of fifteen on the joint Engineering Building given by Mr. Carnegie at a cost of $1,000,000 and upwards, the American Society of Mechanical Engineers has just issued a most interesting circular on the subject embodying a good deal of new material and data. The chief item is the report of the committee on organization, composed of Dr. A. R. Ledoux, C. W. Hunt and Dr. S. S. Wheeler. We give it below:

Having considered legal advice and taken note of all suggestions received, the committee unanimously advise as follows:

1. The total amount offered by Mr. Carnegie shall be administered as two gifts: one to the Engineering Societies and the other to the Engineers' Club, each to be held and administered independent of the other. The allocation of the fund to be made at once, but the buildings to be designed and erected as one operation; thereafter the respective titles and administrations to be entirely independent.

2. The property represented by land, buildings and equipment of the engineering societies, shall be held and administered by an executive corporate body, preferably under a special charter, to be obtained from the State of New York, each of the constituent societies being entitled to name from its membership three persons to act as incorporators and thereafter as directors.

3. Each society annually to elect or appoint, as their by-laws may prescribe, one of their voting members to serve on the Board of Directors of the Executive Corporation for a term of three years; a vacancy in said board to be filled by an appointment made by the society the retirement of whose representative causes the vacancy.

4. The land and property being held for the societies by an Executive Corporation, the said corporation may, to pay for the land acquired, issue certificates of indebtedness or bonds bearing interest at four per cent., and redeemable on six months' notice, the buildings being a gift from Mr. Carnegie.

5. Each of the constituent societies may purchase and hold an equal amount in value of the said bonds or certificates, but the Board of Directors of the Executive Corporation may authorize any of the constituent societies to hold an additional amount; that is, in excess of its portion, but such excess shall be subject to recall at its par value at any time that the directors of the Executive Corporation may so order, to the end that each society shall have an equal interest in the property of the corporation if it so desires.

The certificates held by each society shall be inalienable unless they are offered to the Executive Corporation at their par value, and such tender shall not be accepted by the Board of Directors within one year thereafter.

6. The property of the Executive Corporation shall be used perpetually as a meeting place and headquarters for the constituent societies, and for such other scientific associations as may be temporarily admitted by the consent of the Board of Directors of the Executive Corporation. Such associations may pay a pro rata share in the expenses of the headquarters, but no profit shall be made from such use.

7. Each of the participating societies shall be entitled to rooms and space in the property adequate to its need, paying its share of the running expenses in accordance with the amount of space occupied; said space to be assigned and a proper assessment therefor determined by the Board of Directors of the Executive Corporation.

8. The excess of receipts over expenditures, if any, shall be used for reducing the subsequent contribution of the several societies for maintaining the building, and for the advancing of engineering arts and science, by and through the participating constituent associations. No dividends shall be declared or profits divided, but a reasonable repair and rebuilding fund may be established.

9. If the income of the Executive Corporation shall be less than the expenditure, the deficiency shall be made good by an assessment on each of the constituent societies, so allocated as to be in proportion to the number of voting members of each society.

An excess of receipts over expenditures may be allocated to the societies in like manner to reduce their annual assessment.

10. Should any of the constituent societies fail or refuse to appoint directors, the remaining members of the board of the Executive Corporation shall administer the property with all the force and effect as though the board contained its full quota of members.

11. Finally your committee, in offering the above suggestions, has had in mind the setting aside of the money used for a building for the Engineers' Club, so that on the completion of the said building the relations of the club and of the engineering societies will terminate. Thenceforward, the constituent societies are to carry through the Executive Corporation the administration of the building and its accessories, leaving the scientific, professional, intellectual and financial activity in each organization entirely independent of the others, and free to develop to any extent and along any line that may be determined each for itself.

The details of the superintendence and administration of the buildings can best be considered after the organization of the proposed Executive Corporation through the procuring of a special charter. As to the above report we may add that the ideas and plans that are being developed involve two separate buildings, even without physical union or means of common access, one for the engineering societies and the other for the Engineers' Club. No objections are raised to this in any respect.

An Edison Medal for the Institute.

In order to celebrate the twenty-fifth anniversary of the introduction and commercial development of the incandescent lamp, the friends and associates of Mr. Thomas A. Edison have taken steps to found a medal which will be entrusted to the American Institute of Electrical Engineers, and which it is proposed to award annually to graduating students in electrical engineering. The Institute, through its council, has already accepted the trusteeship of this fund and the circular which is being issued by the Edison Medal Association announces that it is the intention that the medal shall be awarded each year to the graduating student who shall present the best thesis on some original subject, from the universities and colleges of the United States and Canada which have regular courses in electrical engineering. It will be remembered that Mr. Edison's mother was a Canadian; that part of his own active life has been spent in that country, and that to-day the Institute not only selects some of its officers from that country, but that professors and students are freely interchangeable; considerations which render the inclusion of Canada by the founders of the medal eminently appropriate. It is proposed that the medal shall be executed by some artist of distinction and that if possible a permanent fund of about $5,000 shall be established for its maintenance. To carry this purpose into effect an Edison Medal Association has been organized, and it is proposed to present the medal fund at the annual dinner of the Institute on February 11, at which Mr. Edison will be a guest of honor. It is Mr. Edison's birthday also. The dinner is to be held at the Waldorf-Astoria and there is already every indication that it will be one of the most memorable functions of the kind that the Institute has ever enjoyed. The Edison Medal Association has as its officers Mr. Samuel Insull, chairman; Mr. Charles Batchelor as vice-chairman; Mr. Frank S. Hastings as treasurer, and Mr. Robert Ten Eyck Lozier as secretary. These "old Edison men" are reinforced and assisted by an executive committee of some 30 others, all of whom have been intimately associated with Edison developments, and by a general committee of about 100, all of whom have also at some stage of their careers been more or less closely identified with Mr. Edison's work. The Edison Medal Association has also appointed a dinner committee to co-operate with the Institute dinner committee under Mr. Calvin W. Rice, and has appointed other committees on various branches of its work. The executive committee includes Willie S. Andrews, C. Batchelor, Sig. Bergmann, R. R. Bowker, C. A. Coffin, R. N. Dyer, S. B. Eaton, C. L. Edgar, W. E. Gilmore, W. J. Hammer, C. T. Hughes, F. S. Hastings, S. Insull, E. H. Johnson, F. Jehl, A. E. Kennelly, J. W. Lieb, Jr., H. W. Leonard, R. T. E. Lozier, E. H. Lewis, W. S. Mallory, J. P. Morgan, T. C. Martin, J. Ott, J. P. Ord, E. Rathenau, P. Seubel, F. J. Sprague, E. Thurnauer, S. S. Wheeler and F. R. Upton.

A great deal of interest is taken in this movement throughout the Institute ranks and amongst the numerous old associates of Mr. Edison, not only because the first Institute medal will thus be founded, but because one of the great epochs in electrical development will be celebrated. The twenty-fifth anniversary of incandescent lighting is also to be recognized this year at the St. Louis Exposition by the Edison companies; but it has been felt that in its engineering aspects the occasion is one which could be fitly and legitimately used to identify the Institute with the lighting art, and by this representative affair enlarge the sphere of its influence and responsibilities, since the medal is to be put in its charge. The address of Treasurer Hastings is 80 Broadway, New York.

A Combined Steam and Water-Power Central Station at Richmond.

ABOUT five years ago the construction of a power station was begun at Richmond for the Virginia Electrical Railway & Development Company to furnish current as a competitor in the electric railway and the general electric power and lighting business of that city. Water rights along the river at that point had been secured and plans were drawn for a development of 10,000 hp. Owing to the necessity for a continuity of service and in view of the fact that this could not be secured from the river either at low water or in times of freshets, a steam plant was arranged for, equivalent in capacity to the water power. The initial plant, which was completed about two years ago, was only carried for an output of 4,000 hp, but in the meantime the property passed into the hands of the Virginia Passenger & Power Company, which now represents a consolidation of the railway and electric services of Richmond, and during the present year work has been in progress until the full 10,000 hp is now practically available.

Both the hydraulic and the steam ends of the plant are unusually interesting. The former comprehends a long, low dam, provided with flashboards of both the automatic and the non-automatic type, a necessarily small canal to conduct the water to the power house, the limited cross-section creating a comparatively high velocity of flow, and the usually submerged, low-head water wheels. The steam plant includes vertical steam engines of 1,000 hp each, appropriately styled as steeple engines. A specially instructive feature of the station lies in the relative locations of the water and steam machinery and the limitations of their separate or conjoined operation.

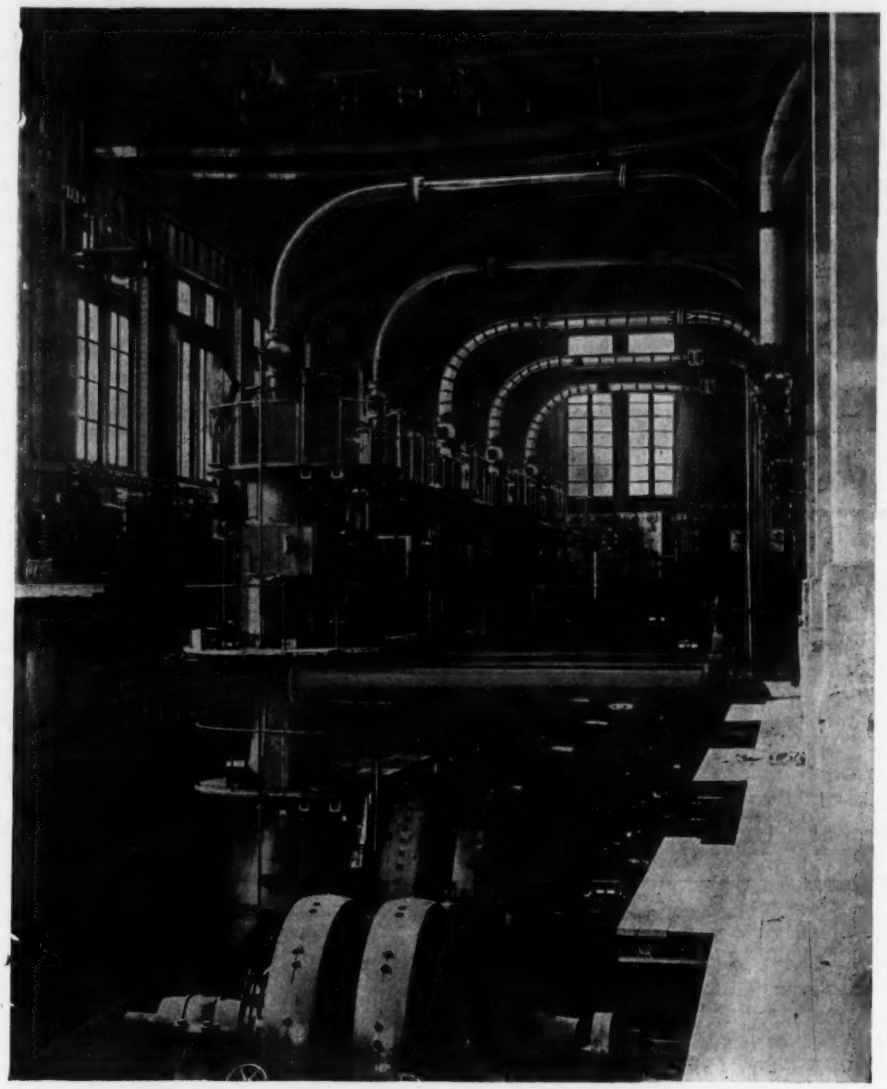


FIG. 1.—VIEW OF ENGINE ROOM.

The water rights were formerly owned by a flouring mill on Johnson's Island. The design and construction of the hydraulic portion of the first completed part of the station, including the power house, was in charge of Mr. Reuben Shirreffs, M.A.Soc.C.E., as chief engineer, now chief engineer directing a water power development at Great Falls, near Washington. Mr. J. H. Apsey was superintendent for Messrs. Winston & Co., of Chicago, contractors on the dam, canal and power house foundations. The steam and electrical features were designed by Mr. E. J. Willis, M.Am.Inst.E.E., now president of the Richmond Electric Company, of Richmond, who was succeeded by Mr. J. P. Pope. Messrs. Sargent & Lundy, of Chicago, were consulting engineers on the steam plant. Since the consolidation of the local companies, in which Mr. Frank Jay Gould, of New York, has a controlling interest, Mr. William C. Whitner has been retained as chief engineer for the water power developments of the Virginia Passenger & Power Company, and under his supervision the power house has been extended, additional units installed, some changes made in the canal and intakes and a new type of dam designed for the portion of the original work that had not yet been completed when Mr. Whitner was appointed.

The city of Richmond is situated at the head of tidewater about 100 miles from the mouth of the James River. In the last three miles above navigation the fall of the river is 84 ft. and within nine miles 112 ft. The watershed of the river is 6,900 sq. miles. Mr. Whitner states that the average rainfall is 42 in., and from records of the Geological Survey assumes that it is not advisable to figure that the minimum flow of the James River at Richmond exceeds 700 cu. ft. per second, or 0.1 ft. per square mile of the catchment basin. About 100 cu. ft. per second pass through the Chesapeake & Ohio Canal and are not available for power. In considering the obtainable power in the river, complication exists owing to the fact that diversion has to be made to the Manchester Canal, which supplies water for operating a number of mills located along its bank. This is the property of the company, but the contracts under which water is furnished could not, practically, be changed. It is estimated that 600 cu. ft. per second are disposed of in this way, under a fall of 19 ft. At periods of very low flow, however, the Manchester Canal tenants are only entitled to one-half the water in the river. The James River plant is designed for a head of 25 ft. and assuming a combined efficiency of the wheels and generators of 75 per cent., and allowing for the diversion to the Manchester Canal, the following schedule of power has been prepared by Mr. Whitner. For five months, 8,846 hp; for six months, 6,242 hp; for eight months, 4,012 hp; for nine months, 2,982 hp; for eleven and a half months, 1,065 hp; minimum, 639 hp. This summary shows the necessity, if it is desired to supply 10,000 hp continually from its plant, for the steam engine adjunct. It shows that if 9,000 hp is the demand, the engines would not have to be operated at all practically for five months; that for one month they would have to supply 2,758 hp; for two months they would have to supply 4,988 hp, and so on. For fifteen days they would have to meet practically the entire demand. Of course, it must be remembered that these results are based on the minimum flow, which is not necessarily an annual occurrence.

The dam extends straight across the river at the upper end of Brown's Island. The hand gate house, which controls the entrance of water to the power canal, is a continuation of the dam, extending from the island to the east bank, to a point on the property of the Tredegar Iron Works. In a contract with that company the level of the water in the pond above the dam was fixed at elevation 44.75, and the level of the water in the canal just below the gate house at elevation 43. The contract also stipulated that the elevation of the top of the dam should not exceed 40.5, but provides that movable crests or flashboards can be used, by which the level of the water in the pond can ordinarily be kept at elevation 44.75. It requires that these flashboards shall be lowered or raised in times of high water so as to maintain the water level as nearly at elevation 44.75 as possible. The canal leading to the power house is 2,200 ft. long and

the power house, at the end, is located at the river side. The elevation of the tail water at the other side of the power house is ordinarily 17, so that the gross head is 26 ft.

The dam is a concrete masonry structure over 1,700 ft. long, inclusive of a guard wall at the upper end of the channel. The average height of the crest is only 5 ft. above the solid granite bed of the river, on which the dam is built. That a head of 26 or 27 ft. is realized with a dam of this height is indicative of the rapid drop in the river between the dam and the power house. The minimum height of dam is about 8 ft. A higher one would probably have been constructed, except for the reasons mentioned, and the probability that serious damage might come to property above the dam at times of extreme freshets. At intervals of 40 ft. concrete piers 4 ft. wide were built along the top of the dam, 10½ ft. above the crest of the dam, to support the structure for moving the flashboards. Their height was taken to bring them above the highest flood levels, and to them are hinged the timber gates or flashboards. When resting on the dam proper these maintain the desired level in the pond, as will be noted in detail below. The movable flashboards are constructed of heavy pine timber in planking and are faced with cotton duck heavily coated with North Carolina tar as a preventive of leakage.

The manipulation of these gates is one of the interesting features of the original design. Timber bridging spans the piers the length of the dam and this carries tracking on which is moved a hand car. The car carries a 3-hp electric motor for hauling up each gate, which is then fastened in its uppermost position, and the car is pushed from gate to gate for this purpose. There are 43 of the dropping crests, all told, each practically 36 ft. long, but the later ones are of an entirely different type. About 1,200 ft. of the dam were completed by the original company, leaving about 560 ft. to be built. This later work has been carried on by Mr. Whitner, who designed the movable crest, which is an interesting feature of the plant. This is designed to be automatic and consists, as shown, of a hinged apron inclined with the direction of flow so that there is a downward pressure on it, due to the presence of water above it. The hinge is at its lower edge, while the upper edge is hung from the end of levers, at the other ends of which is a counterbalance. When the level of the pond rises above the predetermined elevation of 44.51, the weight of the extra amount of water is designed to overbalance the counterweight, so that the apron will descend and lower the rollway crest. It will be noted that the shape of the concrete dam proper at the top is different from that for the old portion on account of the new type of flashboard. The apron consists of 6 x 10-in. pine timbers 9 ft. long, bolted together by iron plates at the bottom and top and strengthened at the top by a 15-in., 42-pound I-beam. There are two levers, one at each end, composed of 12-in., 31½-pound I-beams 15 ft. long, with two lever arms 4 and 10 ft. in length. The apron is suspended from each lever by a heavy chain. The counterweight is a cubical mass of concrete, measuring about 26 cu. ft.

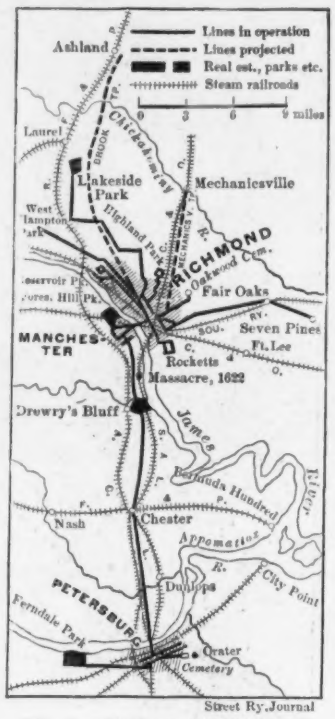


FIG. 2.—MAP OF RAILWAY SYSTEM.

A signal station is maintained at Columbia, Va., about 50 miles upstream, from which reports can be sent to Richmond by telephone of the water level at that point. By this means notices of floods are received twelve hours in advance of a rise at Richmond and men immediately start raising the gates in anticipation of the high water. Of course, with the automatic type of flashboard this is unnecessary.

The upper 900 ft. of the canal is a natural channel, enlarged by an excavation of earth and rock to an average waterway of 1,200 sq. ft. The lower end, or 1,600 ft., has concrete masonry side walls and a smooth lining of concrete on the bottom, the walls to retain the banks, as the width available was limited, and the bottom lining to increase the capacity to carry water, the lower part of the excavation being in solid rock. Its area is about 650 sq. ft. It was estimated that the canal would deliver to the station 5,500 to 6,000 cu. ft. per second with a loss of not more than 12 to 15 in. the whole length. The velocity under these conditions is about 9 ft. per second. To diminish the loss of head as far as possible, an unusual amount of gate area was provided at the head house. There are ten openings, each 12 ft. wide and 8 ft. high. The openings were fitted with heavy timber frames, each of which supports five smaller gates. This division was employed to regulate the supply of water when the river is high, but when the river is low the openings are left unobstructed.

The power house is located, as already stated, parallel to the axis of the canal, so that the forebay is comparatively small, at least where the water has to change its direction 90° before entering the wheel chambers. With the extension of the power house the end canal was enlarged as much as the width of the property would allow and the racks, which were formerly set across the canal, have been put immediately in front of the wheel chambers, increasing the area of flow through them, it is stated, three and one-half times. In connection with them an interesting device has been provided to clean the racks mechanically. The racks are composed of 3½ x ⅜-in. steel bars spaced on 1⅝-in. centers and each rack structure protects an opening 18 ft. wide. The cleaning device comprises a number of large combs, on which the projecting teeth fit in between the bars of the racks, and of endless chains on which the combs are fixed and by which they are moved upward along the rack bars. The comb consists of an angle bar with teeth of ½ x 1-in. iron, pointed, and riveted to the angle on 1⅝-in. centers. The chains are driven at the top by a motor connected to a shaft, which carries the necessary sprocket wheels.

The power house is built on bed rock, and, on account of the great weight of the machinery installed, on the one hand, and the considerable upward pressure of water in extreme freshets, which reach a level of 20 ft. above the boiler room floor, on the other, the foundations have been made unusually massive. The water wheels, which are of the horizontal type, are mounted in pairs, one pair submerged in each wheel chamber. The wheel chambers are arched overhead and support the boiler room for the steam plant. The tail water from the turbines reaches the tailrace through a comparatively long draft tube and across the draft tubes is located the generator room. The shaft from the water wheels extends into this and is directly attached to the generator, and on the other side of the generator is the steam engine, placed also in line for direct connection, when necessary. Under the engine room the entire space excavated is solidly filled with concrete, except for the draft tubes, which are circular in section, 10½ ft. in diameter at the outlet of the wheels, enlarging to 14 ft. at the river wall. The extensive use of concrete masonry is noticeable, as not only the dam, the canal masonry and power house foundations are constructed of it, but the walls and roof of the first portion of the station, the switchbard gallery floor and even the outer shell of the chimney are concrete. Portland cement was used for the most part, except in places where weight only was required, and there natural cement was used. It was stated that the stone from the excavations was unsuitable for stone masonry, and the use of concrete in constructing the building and chimney made architectural effects possible at a comparatively low cost. The foundation work was built in forms and the shaft of the chimney was constructed in the same way. The walls of the superstructure, however, were built of blocks of concrete, previously molded in boxes and laid up in the walls like stone ashlar. This part of the station was built large enough for four units of 1,000 hp each. The extension is designed for six additional 1,000-hp units, so that the capacity will be 10,000 hp.

Six pairs of the water wheels are of the Victor cylinder gate type, built by the Stilwell-Bierce & Smith-Vaile Company. Each is 51 in. in diameter and the pair guaranteed to develop 1,200 hp under a 25-ft. head. The seventh pair of wheels thus far installed consists of Hercules turbines built by the Holyoke Machine Company. The shaft from each pair extends in the usual way to the engine room through an opening in the partition wall. Each generator is a continuous-current machine of 700-kw capacity, built by the General Electric Company. The engines are steeple tandem-compound Allis engines. They are arranged to run condensing or non-condensing and are rated at 750 hp and at best economy are capable of delivering 1,500 hp. The water wheels are controlled by Lombard governors.

The steam engine cylinders are 18 and 36 in. in diameter with a 42-in. stroke, and they are equipped with the Reynolds valve gear and ball governors. A bolted flange coupling effects the connection between the turbines and the generators. The engine fly-wheel, which weighs 80,000 pounds, is mounted between the generator bearings and runs with the generator, whether driven by the turbine or engine. The engines are disconnected by uncoupling the connecting rods from the crank pins. To change from the water to the steam plant, bolts are removed from the couplings and the connecting rod is connected to the crank pin. To change from steam to water the operation is, of course, reversed. It is stated that the change requires about 45 minutes. The reason that the engines have a most economical rating at the comparatively low power is that this machinery is depended on to operate alone but for a small portion of the year. They are intended principally to supplement the wheels in time of low water and to maintain proper speed in the turbines at high water.

The condensing plant presents an interesting combination of two Worthington elevated injector condensers set at different levels. The lower one is operated normally under the head existing between the canal and the river. The second condenser is provided with an electrically-driven centrifugal pump, which has a capacity of 1,600 gallons per minute, to meet the conditions of high water when the natural head may prove insufficient. The condenser plant has a rated capacity of 6,000 hp. It is provided with a double-acting Worthington dry vacuum pump, 10 x 18 x 18 in. in size.

The boiler installation consists of four 1,000-hp batteries of Babcock & Wilcox water tube boilers, each having 252 tubes 4 in. in diameter and 18 ft. long, and three steam drums 3½ ft. in diameter and 20 ft. 4 in. long. They are rated at 500 hp each, on the basis of 10 sq. ft. of heating surface per horse-power and 0.2 sq. ft. of grate surface per horse-power, so that the ratio of grate area to heating surface is 1 to 50. The ultimate steam capacity of the plant is 4,000 hp.

It will be noted from the cross-section drawing of the station that coal is delivered in the railroad cars pushed on a trestle in the boiler room. The coal is readily dumped immediately in front of the boilers and there is storage capacity for about 120 tons. Semi-bituminous coal is used and as labor is cheap and the boilers are not operated continuously, they are hand-fired. The chimney is 11 ft. in diameter and 175 ft. high above the boiler grates. Feed water is drawn from the canal; but there is, also, a connection with the city mains, so that in times of excessive turpidity in the canal the boilers may be kept free from scale-forming water. There are two feed pumps of the Knowles duplex type, 6 x 10 x 12 in. in dimension. The water

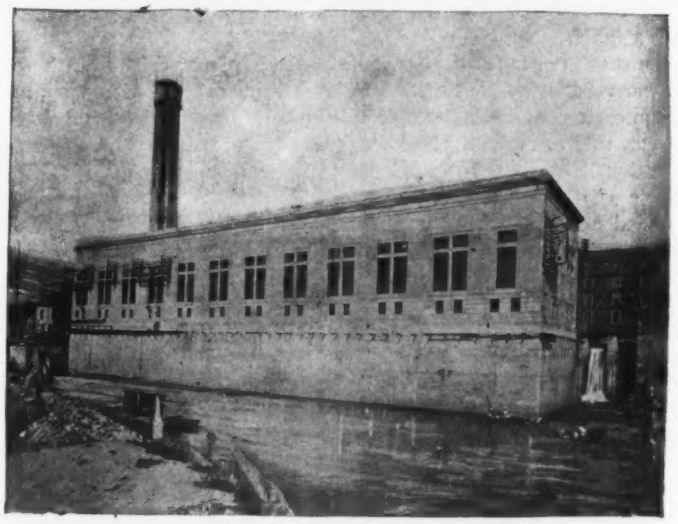


FIG. 3.—EXTERIOR VIEW OF HYDRAULIC POWER HOUSE.

is discharged by the pumps through a Berryman feed water heater, 36 in. in diameter, provided with the usual by-passes for both the exhaust steam and the feed water. The only steam passing through the heater is that from the dry vacuum and the feed water.

The steam pressure is 150 pounds per sq. in., and extra heavy wrought-iron flanged pipe was installed for all the steam mains. The Chapman valves are employed, and the high-pressure mains and pipes are drained into the boilers by means of the Holly system. The steam header is 14 in. in diameter and the exhaust header 36 in.

In addition to the machinery described, there are two drainage pumps on the engine room floor with a combined capacity of 600 gallons per minute, furnished to handle any water which may percolate through the masonry during freshets. A 25-ton traveling crane built by the Whiting Foundry Equipment Company spans the engine room.

Being an independent company when the work was instituted, a variety of service was arranged for. The switchboards, which are situated on a gallery running around the engine room, are quite extensive. Direct current is supplied for railway work and for light and power, and for the latter there are two high and two low bus-bars and one common neutral bus on the lighting panels, the Edison system of distribution being employed. Alternating current is also furnished, and besides the generator and exciter panels, the switchboard has 10 railway feeder panels, 10 Edison panels and 2 alternating-current panels. The unusual feature is presented of a water power station situated almost at the center of its load, two-thirds of it being located within a radius of 1½ miles. On this account the three-wire system of distribution was adopted, 235 volts for light and 470 for power, reserving the alternating system for service out-

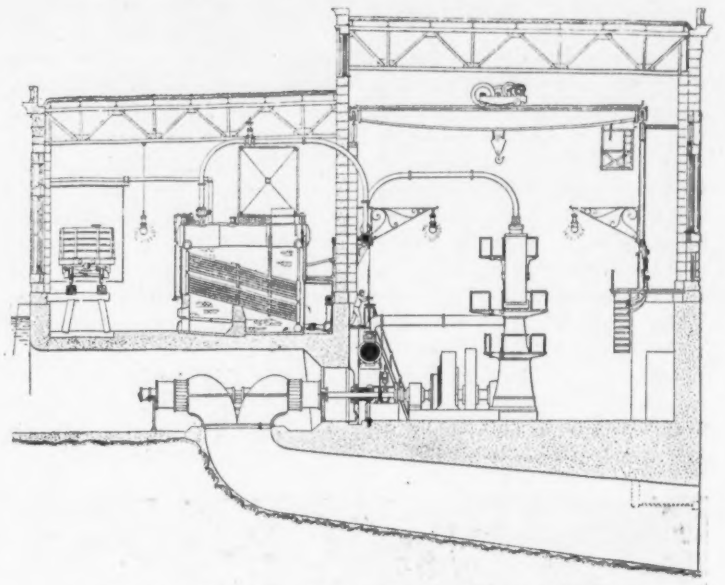


FIG. 4.—CROSS SECTION DIAGRAM OF POWER HOUSE.

side this zone. The voltage for this service is 2,300 at the station, with transformation to 115 volts, for local distribution. The railway current is, of course, delivered at 550 volts. The current is distributed both through underground conduits and overhead feeders. In the former the conductors are rubber-covered lead-enclosed feeders, furnished by the John A. Roebling's Sons Company. The electric controlling apparatus is of standard General Electric manufacture.

The officers of the Virginia Passenger & Power Company is as follows: President, Mr. F. Sitterding, of Richmond; first vice-president, Mr. Frank Jay Gould, of New York; second vice-president, Mr. Augustus Wright, of Petersburg; secretary and treasurer, Mr. Guy Phillips, of New York; assistant secretary and treasurer, Mr. William Northrop, of Richmond. The late construction work, except the extension to the power house, which was erected by Mr. John Mann, Jr., was done by the company's own forces.

A Long Trolley Line.

A telegram from Richmond, Ind., of January 1 says: "If the plans of the men who are the power behind the Columbus, Greensburg & Richmond Traction Company materialize the company will have one of the greatest systems of trolley lines in the world. The plans contemplate not only a line from Columbus through Greensburg to Richmond, but also several long branch lines. One is to run to Louisville. Another is to run into Cincinnati. At Greenfield connection will be made with the Indianapolis & Eastern for Indianapolis. The line to Richmond is not merely to run into this city, but is to extend through the city and east to Cleveland, with Buffalo as its ultimate terminal. This would give the company direct connections with Indianapolis, Louisville, Cincinnati, Cleveland and Buffalo. The third-rail system is to be used except inside the corporations, where it is necessary to resort to overhead construction. The company will make use of private right of way."

The Government Printing Office—The Electrical Equipment of the Largest Printing Office in the World.—II.

DISTRIBUTION, ETC.

IN the first part of this article it was attempted to give an account of the Government Printing Office at Washington, as the largest printing office in the world, and that in which the application of electricity to the various processes of typography finds its most notable example as well as its furthest reach up to date. That part of the article dealt with the building, the nature and extent of the work done in it, the size of the staff employed, the power plant and the electrical generating apparatus. It is now proposed to deal with the distribution of the current and its utilization in running motors, heating, ventilating, lighting, etc. But before entering upon this part of the subject, which embraces the Office as a going concern, which, with the New Year has barely got into full swing, it is appropriate to note the fact that even before there was a new building, Mr. Tapley had to operate his plant for all it was worth, during the trying period of erection. In a rather curious manner, therefore, typically illustrative of the flexibility of electric power, the Office has shown what can be done in building operations with a handy and adequate source of current. For instance, all of the steel structure was raised by electric hoists, and virtually all the brick, mortar and cement and other general building material was elevated in the same way. Electrical pumps were used during the digging of the foundations, for removing the surface water. In the laying of the wood block floor, current was used for heating the mastic which holds the maple onto the concrete flooring bed. Portable saws and other woodworking machinery were supplied with electric drive, and all the planing of the floors was done by specially constructed machines propelled by electric motors. This contract was carried out by Mr. James G. Wilson, of New York City.

Such "distribution" as was required for this special work was necessarily more or less transient and temporary, but from the very first elaborate plans had to be worked out providing for all main and branch circuits in a building of steel, whose iron floor construc-

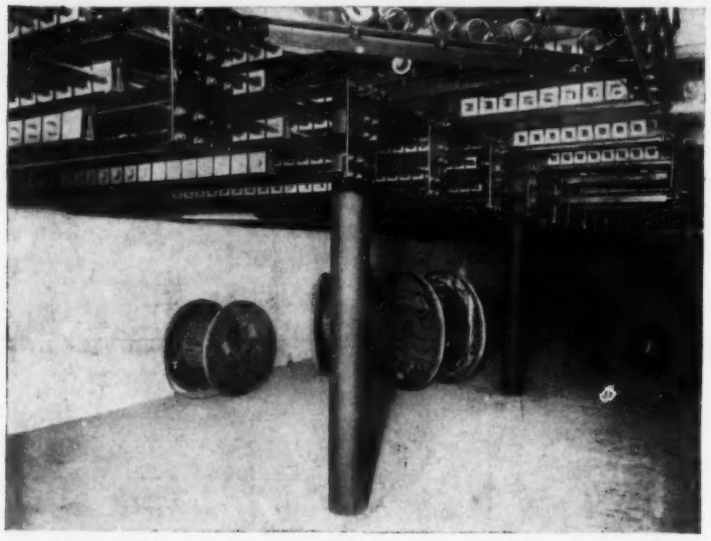


FIG. 12.—CABLE VAULT.

tion is covered with two to four inches of fireproof material, such as concrete, and yet where the work would demand the extension to innumerable points of wires capable of delivering current enough to run extremely heavy machinery. Moreover, two distinct services had to be provided for, light and power, besides which the use of electricity in large volume for elevators, heating, ventilating, etc., made further exactions only to be fully comprehended by a study of the building itself, over whose endless floors one may wander for days, encountering some new application of electricity or electric motor at every turn.

As might be expected, some wiring between floors and walls is enclosed in conduit, as well as at points of emergence around machines, and some idea of the extent of the work involved is faintly indicated by the data given in the report of the chief of engineers, United States War Department, who, by some odd twist of governmental regime, appears to have had the construction of this building under his direction and supervision, although it is obviously one of the most pacific branches of the public service. The figures submitted by Captain J. S. Sewell, United States Corps of Engineers, to General Gillespie, show that up to November 28, the sum of $123,147 had been expended on electric wiring, the work on which, by the way, was done by the electrical force of the Printing Office—a most creditable fact. The scope of the work is also indicated by the material used in the electrical installation, including 13,094 linear feet of terra conduit; 55,068 feet of flexible metal conduit; 14,000 pieces of lead bushing for the flexible conduit; 1,822 iron outlet and junction boxes; 8,248 pieces of enameled pipe; 145,811 fittings of all kinds; 394,375 feet of wire of all classes, or about 75 miles; 1,649 C. S. switches; 91 distributing centers; 1,490 feet of lead tubing and 807 feet of ¾-in. black pipe; 1,490 cut-outs; 2 automatic switches; 1,310 castings of all kinds, and 7 galvanized iron boilers of 30-gallon capacity each, employed with pneumatic door openers. This is no mean bill of supplies.

As a general thing, the column fixtures are the essential feature

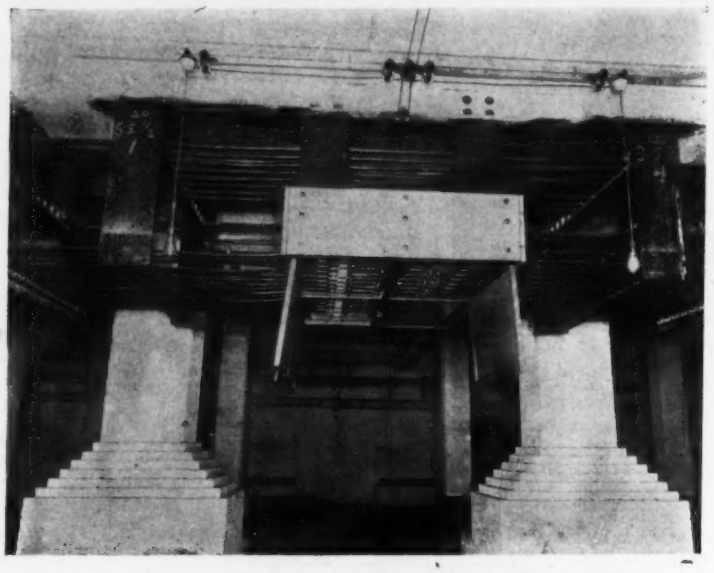


FIG. 13.—LIGHTING DISTRIBUTION CENTER.

of the lighting, but such departments as the composing room and the proof-reading room are a maze of drop lights on flexible cord. Of these applications more anon. It will, however, be readily understood that what is essentially an entirely new system had to be worked out for distributing the electric light and power conductors throughout such a building.

The contract for furnishing some of the wire and cables for the office was made with the Safety Insulated Wire & Cable Company, and amounted to over 100 miles of conductors ranging in size from 1,000,000 cm. to No. 12 B. & S. gauge. The specifications were the most rigid that have ever been received by that company for inside wiring. Article 37 of the contract being as follows: "All rubber wire, both stranded and solid conductors, shall have an insulation of seamless rubber compound, containing not less than 40 per cent. of pure Para rubber, and shall show an insulation test of not less than 1,200 megohms per mile; must be concentric and free from flaws and holes; must have a smooth surface and circular section."

The insulation was guaranteed to stand a rise in temperature of 100 degs. F. above the surrounding atmosphere, and not be affected by either acid or alkaline solutions. It was specified that all wires and cables furnished should be submerged in water for two weeks at a temperature of 76 degs. F., before the insulation resistances were taken. No. 12 wire was used in all cases for circuit work instead of No. 14, as is ordinarily used in commercial installations. The circuit wire was constructed under special specifications drawn by Mr. Tapley, as electrical engineer of the Office, and was designed to withstand not only the exacting electrical heat, acid and alkaline tests, as noted above, but such abrasion as would ensure its safety against rough handling in drawing through the miles of conduits used in the Printing Office. As a special precaution, after manufacture, all of the wires and cables were submerged in water, and an alternating current of 5,000 volts pressure was applied between the conductors and the water. This test showed a factor of safety of fifty times the actual working pressure.

The cable racks shown in the vault extend a considerable distance, and are built up in four tiers and supported, as shown clearly in the

cut. All the cast iron and steel parts received either one or two coats of asphaltum paint or japanned finish, and the insulator clamps like all the castings in the work are of a tough, close-grained gray iron. The porcelain insulator blocks are of dense material, glazed and tested to withstand 10,000 volts alternating current without breakdown.

The terra cotta conduit used, furnished by the Potomac Terra Cotta Company, of Washington, D. C., is composed of single duct 24 inches in length, vitrified and glazed inside and out, with exterior dimensions about 4 inches square, and with a hole in the duct 3¼ inches in diameter. Each piece of duct is provided with iron dowel pins. The outlet holes of all tile are 2½ inches. The steel pipe employed is enamel, having a thickness of 1-16 inch evenly applied, leaving a smooth interior wall guaranteed for ten years to be free from cracks and flaking, and with an insulation between metal and enamel equal to 5 megohms. The iron armored conduit of which four or five thousand feet have been used, is ¾ inch with heavy wall. A large amount of flexible iron conduit has also been used, amounting to several thousand feet of ¾ and 1-inch sizes, and it is of the spiralized flexible metallic Greenfield type made by the Sprague Electric Company. A striking illustration of its flexibility is shown in one of the engravings which portrays a run at an elevator shaft, where it has been brought up a lattice column and looped around and across. The circuits thus run through pipe and by means of the vent shafts run to over 1,800 metal outlet boxes, as noted above, all of cast iron with interior insulation, and of a general dimension of 3¼ by 3¼ inches inside measurement, and to switch boxes of corresponding number equipped with C. S. double-pole

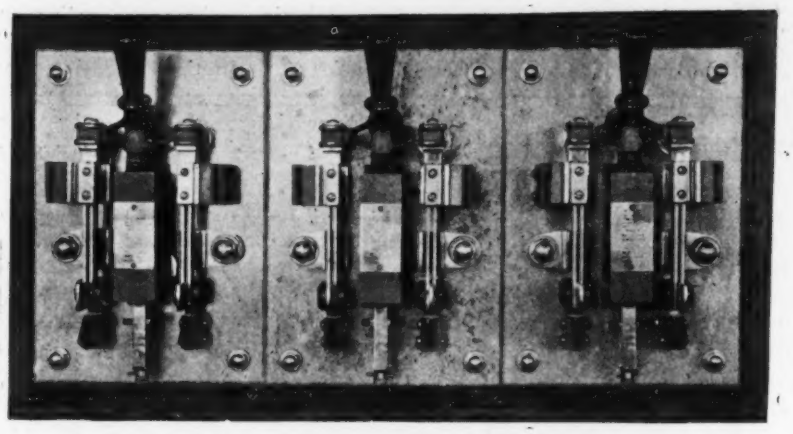


FIG. 14.—DISTRIBUTING CENTER AND CIRCUIT-BREAKERS.

flush switches made by the Cutter Electric Manufacturing Company, of Philadelphia.

The proper distribution of the electric circuits necessary for supplying both light and power in a modern fireproof structure is a subject that needs much thought and consideration before the final arrangements are decided upon and to the structure itself. This is one of the principal features in the wiring of this building. The general scheme is as follows: There is provided an air space between the ceiling and the fireproof flooring of from 10½ inches, bottom of floor beam to top of ceiling beam to a maximum distance of 19 inches from crown of floor arch to ceiling line. This provides a space where all wires are readily accessible. The selection of the fire proofing and floor construction was finally settled upon as being the best suited to an electrical distribution which has to be constantly changed, that is, there must be means of ready accessibility not only to the power circuits but also to the lighting as well. At the same time the floor construction must not be weakened by having a large number of holes drilled through it, which is necessary as will be seen from the subsequent description of the power and press installation.

The system as a whole might be most properly designated as an open-concealed installation, which is readily to be understood from the illustrations which accompany this article. The auxiliary feeders are all supported upon porcelain insulators carried in specially constructed insulator clamps which in turn are fastened to the three-inch I ceiling beams.

The main feeders come direct from the switchboard to the cable vault where they are carried upon porcelain insulators themselves secured to special iron cable supports thence to the vent shafts which run from the basement to the loft, in which are another type of special insulators fastened to channel iron which are so placed as not to interfere in any way with the main design of these shafts, namely, ventilation of the various floors. It provides, however, a very accessible means of making additions or alterations in either the lighting or power circuits now or in the future without in any way installing new conduits or having to cut the ceiling of the building for such work.

In the basement both in the north and south wings of the building are placed two distributing centers into which the main lighting feeders are connected, from this branch laterally the auxiliary feeders entering ultimately the extreme east and west vent shafts of

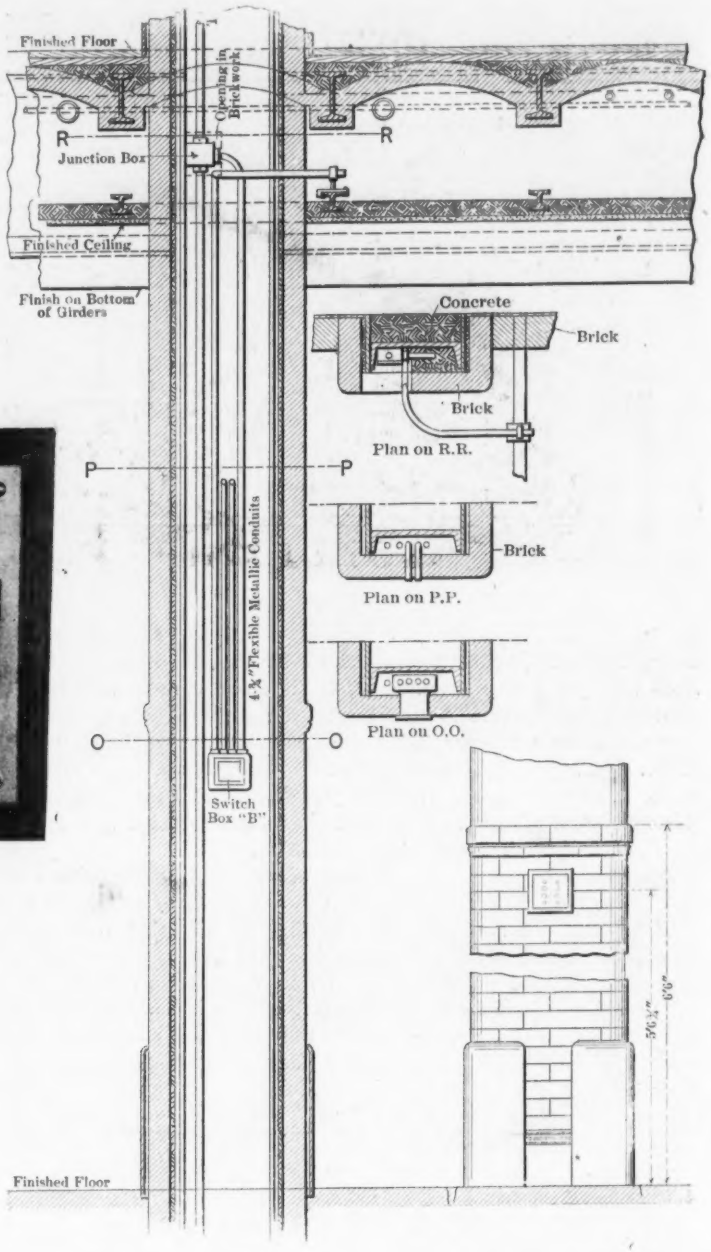


FIG. 15.—SECTIONAL VIEW OF COLUMN, WITH CONDUITS AND SWITCH AND JUNCTION BOXES.

their respective wings in which they rise to the individual floors, where they enter a specially devised distributing center consisting of three circuit breakers mounted upon a common bus, which in turn is the connecting link of the main floor crib. All floors are wired on the crib system, the center circuit breaker being used as a tie switch, thus allowing double the number of lights to be installed on the crib without any subsequent drop in voltage.

ELECTRIC LIGHTING.

From the main floor lighting crib is made a tap at every column from which the wires are conducted through flexible metal conduit to switches located on the east and west sides of the columns in the building. The switches on the east side control the lights of their respective north and south bays, while the switches on the

west side are used for controlling the general illumination, which is obtained by means of 12 lights uniformly distributed around the sides. Two of these lights are used for pilot lighting, which provides sufficient light for the watch force when the Office is not engaged in night work. This pilot system is controlled by one general circuit located in the basement, to which are connected vertical feeders for each column. This pilot circuit is connected to an individual switch on the main switchboard giving the switchboard attendant full control over the lighting system and thus cutting down to a minimum the use of current for this purpose.

The individual lighting throughout the entire building, except in the executive offices, main hall and column lighting as mentioned

FIG. 16.—VIEW IN COMPOSING ROOM.

before is entirely done by means of individual pendant lighting. Each bay, practically 12 ft. by 34 ft., is taken care of by an independent auxiliary crib located inside of the ceiling space to which taps are made wherever lights are desired. Wiring for the individual lighting is figured on the basis of one 16-cp. lamp to every 25 sq. ft. of floor space. In some places, such as composing rooms, this maximum allowance is used, while in others there is not more than one-half of the original proportion in use.

The power circuits are conducted in a similar manner from the switchboard to their respective vent shafts with the exception that there are no distributing centers in the basement, but each power circuit is continuous from the switchboard to its respective distributing center located on the vent shaft near the ceiling of the floor below which it is to feed. The general scheme is for the power circuits to lead up through the floor to the individual motors wherever located while the lighting connections are made to the ceiling of the floor below.

On every floor there are four lateral power feeders extending the entire length of the building from which power is given to individual motors when located within the radius of a few of same. The feeders themselves are in turn connected by ties to the individual circuit breakers located on the distributing centers. The floor girders are 33 inches in depth, extending 10 inches below the ceiling line. Means of providing for these lateral runs through both steel girders and their surrounding fire proofing is accomplished by having the girders punched at the proper place and a steel tubing thoroughly enameled being inserted in this hole and its end projecting 1 inch either side of the fire-proofing of the girders, thus providing continuous porcelain support for the feeders from one end of the building to the other, the supports between girders being special insulator clamps fastened to tie rods 4 ft. on centers. There was installed in the outer walls of the building and in every bay a vertical run of terra cotta conduit having openings inside of the ceiling space and at 6 ft. from the floor at every story. This makes it possible to run wires throughout the entire building with the ability to reach any place desired without having to cut the walls or in any way disfiguring the interior of the building, which is of enameled and white hard-burned bricks.

Mr. Tapley has used throughout the entire installation, with exception of the taps from the auxiliary cribs to switches and their returns, weather-proof wire, thus effecting a saving between rubber and fireproof insulation of a sum sufficient to pay for the cable supports in the basement and vent shafts. This wire being subjected constantly to a warm, dry atmosphere the insulation will be in much better condition ten years hence than had rubber insulation been used for the mains and feeders.

The cost of this system was very much less with regard to both material and labor than had conduit system been adopted. The cost of alterations and additions are practically nothing in comparison to what this would have been had no means been provided of ready access to all wires in the building. In a large institution of this character it is impossible to see ahead three or four years, and thus it becomes necessary to provide some such means as adopted here, unless they were to disfigure the building every time an alteration of lights or of machinery are needed for the benefit of the service. No argument is needed on this score for a careful study of the illustrations shown will demonstrate the great practibility of this system over the ordinary iron pipe installation.

As a general thing, as already noted, the column fixtures are the essential feature of the lighting on all floors, and they are clearly illustrated in many of the engravings as well as in detail. The column fixture is a simple band of metal of plain but graceful appearance, having three lights on each side of the column. It is noteworthy that here as well as in the halls, in fact, throughout the building, incandescent lighting reigns supreme, while, of course, in the halls of the first and second stories, or where the general public has access the fixtures are of a more costly and decorative type, especially at the marble stairway of the front entrance.

Views are also shown of the lighting in the proof-reading and composing rooms, where there is a maze of drop lights on flexible cord supplementing the column fixtures. In the composing room over the type cases, Mr. Tapley has worked out and installed a simple but ingenious device, as shown in one of the cuts, by means of which the possibility of breaking the cord or the lamp is reduced to a minimum. As will be seen the lamp can be slid along a hori-

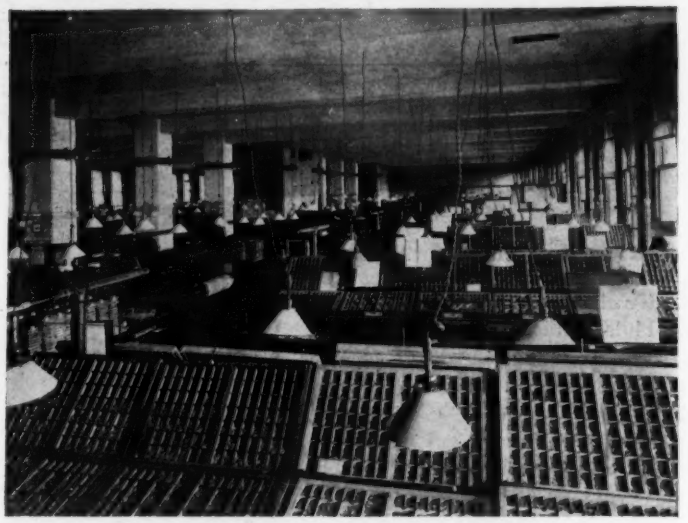


FIG. 17.—SPECIAL FIXTURES OVER TYPE CASES.

zontal wire or rod which extends from end to end of the row of type cases, and even if he moves his position only an inch or two, the compositor can at once slide his lamp along the wire and it assumes and keeps the position in which he wants it without any further manipulation or attention. The handle by which the lamp and its shade are shifted about on the supporting wire can be seen over the various type cases.

ELECTRIC ELEVATFRS.

One of the most interesting and important parts of the plant is the elevator equipment, to which incidental reference has already been made. The elevator system was designed by Mr. E. R. Carichoff, of the Otis Elevator Company, to meet the special conditions laid down very rigorously in the government specifications. All the elevator mechanism is, of course, installed on the basement floor, and the elevator shafts are designated clearly as to location on one of the plans already published in the first part of this article. The elevator plant consists of thirteen large machines, eight of which are for passenger service and five for freight service, and two form lifts,

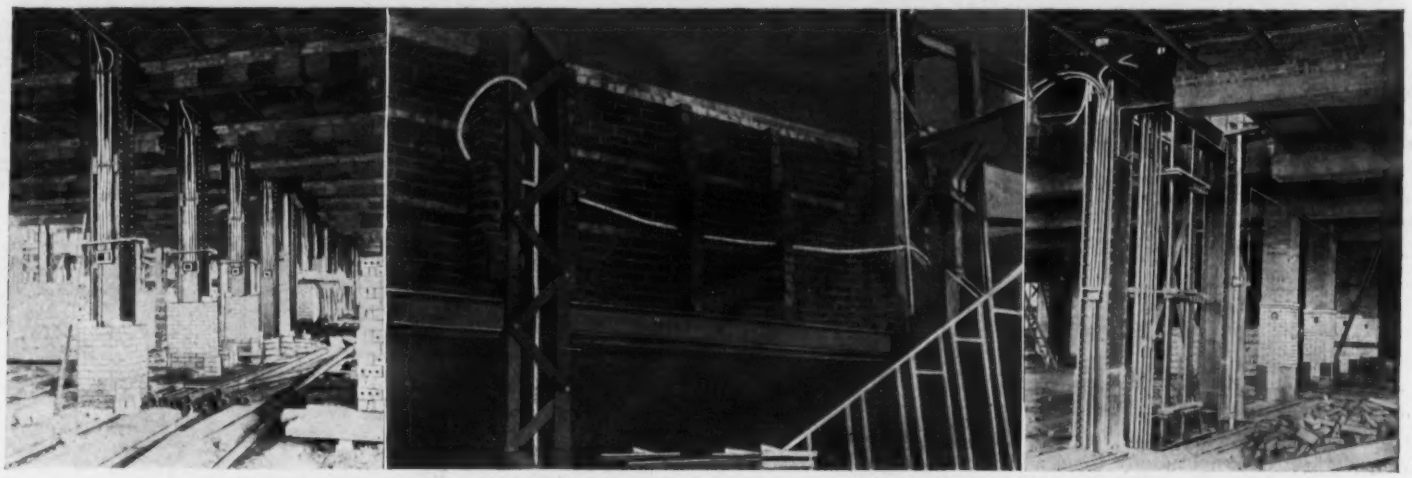


FIG. 18.—STRAIGHT RUNS OF CONDUIT, CABLE VENT SHAFT AND A FLEXIBLE CONDUIT LOOP.

FIG. 19.—RUNS OF CONDUIT WITH OUTLET BOXES ON COLUMNS.

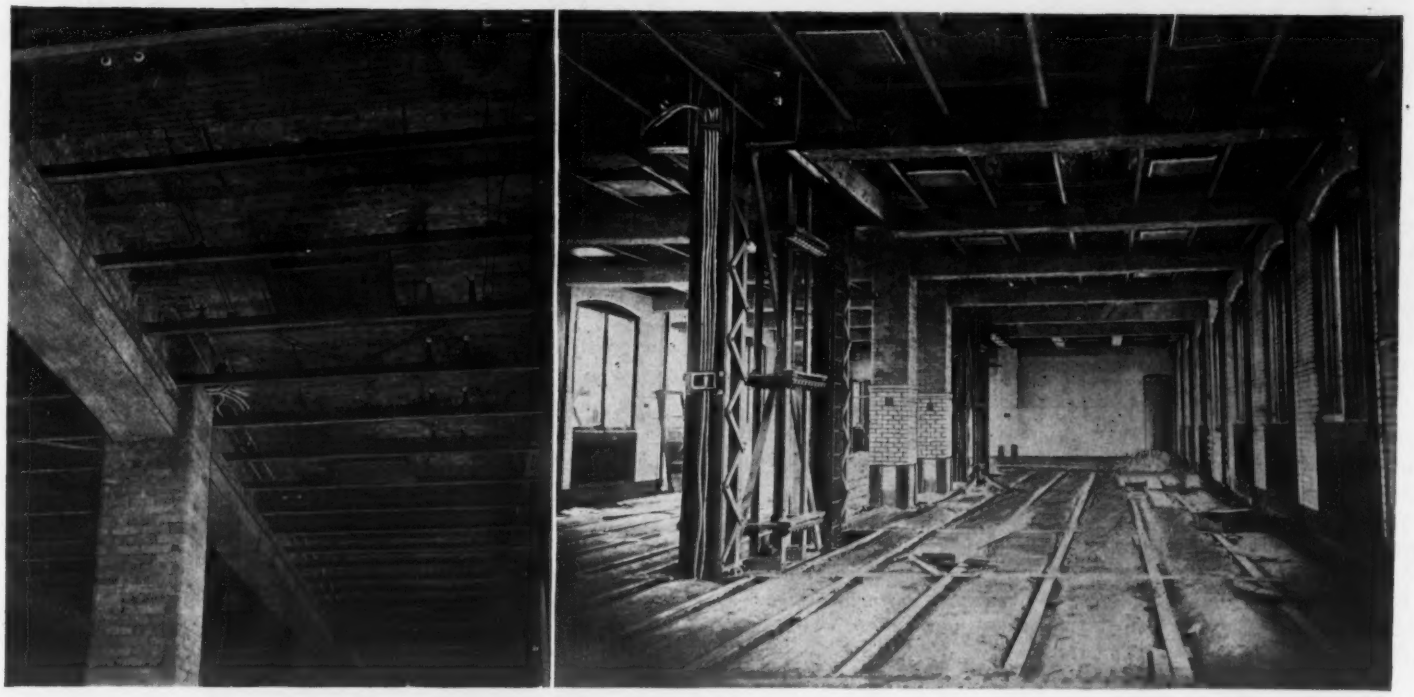


FIG. 20.—DISTRIBUTION CRIB ON CEILING, AND CONDUITS AND CABLES IN VENT SHAFTS.

which are automatic push-button elevators for carrying forms of set up type. The large machines have a capacity of 5,000 lbs. at 350 ft. per minute, and one of the freight machines is provided with changeable back gears at the drum, which increase its lifting capacity to 10,000 lbs. at a reduced speed.

All of the machines are of the worm-gear drive-winding drum type. The worm gears are cut according to the Hindley form, to insure the maximum contact surface. The two worms are cut on one forged shaft, and interlocking spur gears bolted to the side of the worm wheels take up the end thrust of the worms. The taper ends of the worm shaft and the armature enter the face couplings connecting the motor to the worm shaft—one-half of the coupling forming the brake pulley.

A glance at the cut of the isolated machine (Figs. 22 and 23) shows the substantial character of the construction, and also how readily adjustments may be made of brake tension and for wear of shoes. No live parts are exposed at any time, and the motor may be entirely closed or the covers may be removed as desired.

The wires from the motor to the controller run in flexible loon through insulated water-tight ironpipes and less than one per cent drop of potential occurs between motor and controller. Fig. 24 shows a single controller, the parts of which are mounted on two-inch Tennessee marble supported on angle irons from a cast iron base. The two reversing switches are shown near the bottom. The long coil in the centre operates the fingers for regulating the resistance for starting and stopping, and is controlled in both operations independently by an oil retarder.

FIG. 21.—VIEW IN PROOFREADING ROOM.

The small heavy wire coil at the right, near the middle, limits the input of current, and the small magnet at the left varies the field strength and speed of the main motor. On the upper right corner is placed an independent overload no-voltage circuit breaker, which may be opened by the car at extreme limit of travel or by the operator in car in emergency cases. On the upper left corner of the board is a recording wattmeter, which with the counting device attached to the machine permits readings of energy consumed by the machine and feet traveled by the car.

The two reversing switches and the variable speed magnet are controlled by the car switch which is entirely enclosed, self-oiling, and provided with spring return to off position and lock to prevent accidental movement. A covered stop motion switch on the machine brings the car to a stop at the top and bottom of travel. A centrifugal governor switch on the machine forbids excessive speed. The safety grip for holding the car on the rails is operated by a speed governor at the top of the hoistway, and may be thrown on by the operator in the car. This action controls the switches which immediately stop the machine. The guide rails for the car are cold-rolled steel, and are supported every four feet by reamed bolts. The overhead construction work has no holes in the flanges of beams.

The passenger cars have bronze cages and other parts are made to correspond in finish. Throughout the work is of the highest grade, and the operation of the cars is prompt and at the same time exceedingly smooth.

The scheme of motor connections herewith (Fig. 25) shows that one resistance is used for starting and stopping the motor. It will be interesting to refer to this diagram in detail. When all the switches are down the armature is seen to be on closed circuit of low resistance. It will also be noted that a small quantity of current is allowed to pass through the shunt field by the resistance *F R*. This current is less than two amperes on 110-volt circuit, but is

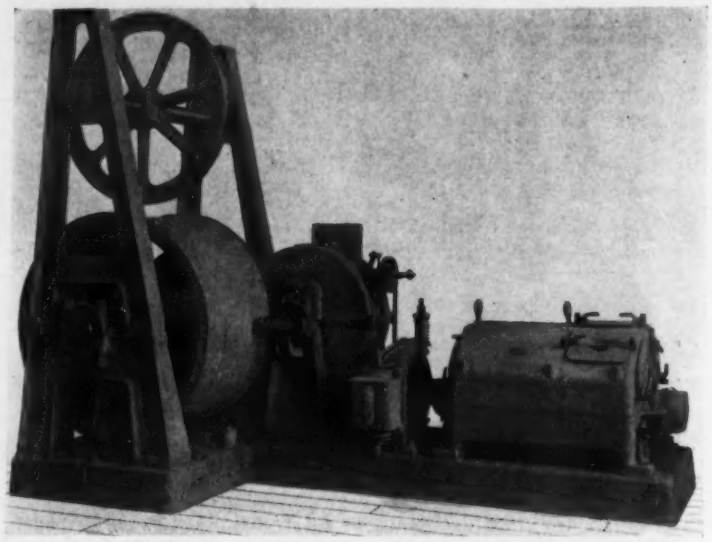


FIG. 22.—VIEW OF SINGLE ELEVATOR.

sufficient in connection with the resistance *S* to provide a dynamic brake for stopping.

Beginning with the switches in this position, the operation may be described as follows: Let the car switch be moved toward up. The first movement sends current from the plus line through the wire - *c* to the car switch, and thence through the contact *U* and the *U* limit to the up magnet, thence through the wire *U*, and bridges 6 and 7 and wire -*c* to - line. The up magnet is now lifted, bridge No. 1 making the circuit from - line to *I*, and bridge No. 2 making the cir-

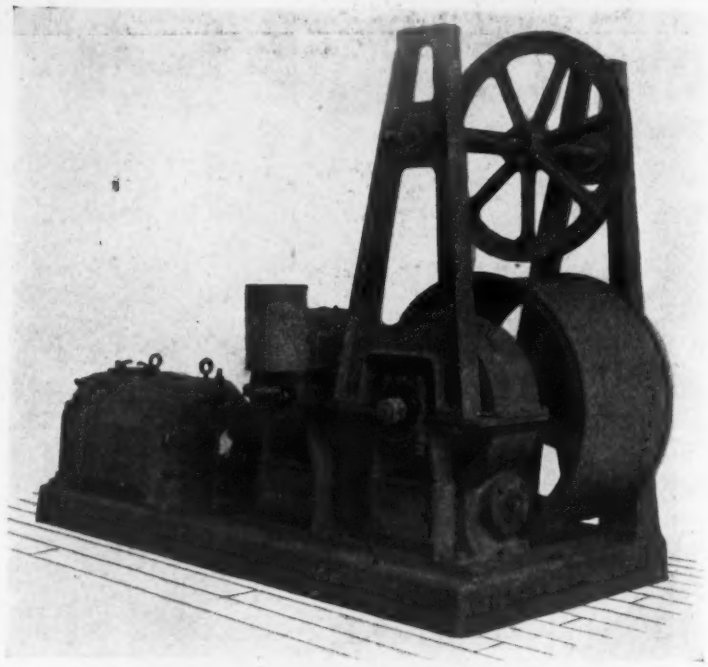


FIG. 23.—VIEW OF SINGLE ELEVATOR.

cuit from - line to *Ro*. The bridge No. 2 being electrically connected to bridge No. 3, connection is also made between the - line and the lines -*B* and -*SF*. Current now passes from - line to the brush *I*, and through the armature to the brush *E*, thence through the regulator brush and resistance to *Ro* and back to - line.

Current also passes from - line through the wire -*SF* to the shunt field and thence through bridge No. 9 to the wire -*SF* and through bridges No. 2 and No. 3 to - line. The brake circuit is also com-

pleted from - line through bridges 10, 3 and 2. The regulator circuit is completed through bridges 10, 11, 3 and 2.

Supposing the car switch to remain in the position just described the armature begins to rotate and resistance is cut out by the regulator. The throttle magnet is operated by a series coil in the armature circuit, and should the current become excessive, it lifts breaking the regulator circuit at bridge 11. The regulator then receives current only through the resistance *A. R. T.*, and ceases to move.

When the regulator reaches the top of its movement, it lifts bridge No. 10. This cuts resistance *A. R. B.* into the brake circuit, and resistance *A. R. S.* into the regulator circuit, so that these coils do not become heated. The bridge 10 also completes the circuit to the fast speed magnet, so that if the car switch is now moved so as to send current through contact *F*, the fast speed magnet will be lifted cutting in the field resistance. The motor then runs with increased speed and weakened field. Should the car switch be turned at once to "full speed," the fast speed magnet cannot operate until the regulator has completed its upward movement.

As the car switch is returned to the central position, either by hand or by the action of its own centralizing spring, the fast speed and the reversing switch magnets are demagnetized and fall, placing the armature in a closed circuit of high resistance, the resistance brushes being now at the top of their travel. The regulator is retarded in its descent, so that the resistance in circuit is gradually reduced until the circuits are as shown in the diagram. This action affords a gradual dynamic brake.

It is seen that the reversing switches cannot be operated unless the resistance brushes are at the lowest position where all the starting resistance is in circuit, as soon as one of the reversing switches is energized.

Resistance tubes of suitable capacity are inserted in the operating coils after action, so that the temperature rise is hardly appreciable. This and the mode of winding of coils insures absolute indestructibility. The contacts are of ample capacity, readily renewable as will be seen by a glance at the engraving of the controller. Indeed, some of the elevators have been in operation for a year, and experience so far indicates that the cost of maintenance will be almost nothing.

Reference has also been made to the two form lifts of the "push-

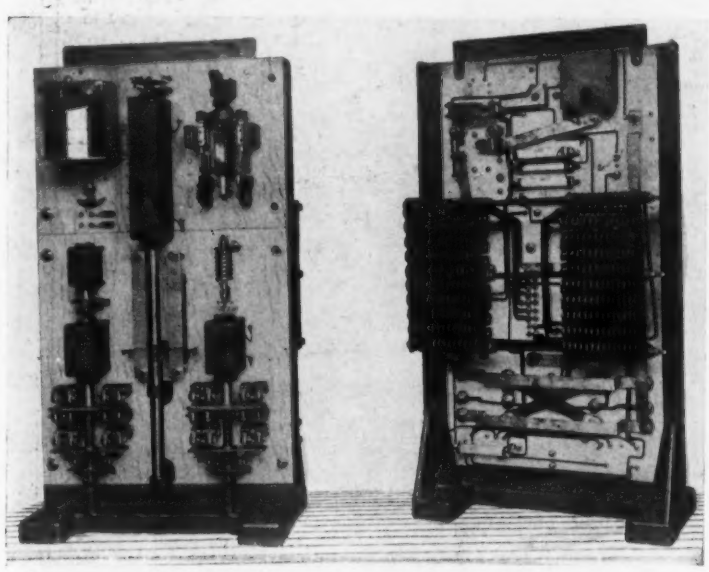


FIG. 24.—VIEWS OF ELEVATOR CONTROLLER.

button" type, operating between the composing room and the press-room floors. These were also supplied by the Otis Company. On the form lifts exact stops are made from a speed of 300 ft. per minute by the automatic slowing device, which operates only at the landing for which the car is destined. At the same floor a signal lamp remains lighted and the car is held until the load is removed or put on and the door closed, when the car may be directed to any other floor. The total lift is 100 ft. The hoists are provided in permanent elevator shafts, housed in well above the floor, and are each equipped with a 10-hp motor, 110 volts, direct current. The cars are 4 ft. by 6 ft. 6 in., so that a large "chase" can be handled quickly; and it will have been understood from previous passages in this article that the hoists are a material factor in securing the great dispatch with which much of the work is executed.

ELECTRIC HEATING APPLICATIONS.

Perhaps the application of the motors to the presses might be considered next to the elevators, but there are one or two other branches of service of equal interest if not equal scope which fall in place here for treatment. Most striking and noteworthy of these is the use of electric heating. Unless we are greatly mistaken Mr. Tapley has in service one of the largest electric heating systems in the world; certainly the largest that is known in the field of printing and publication. Here again the work is characterized by a great deal of originality and thoroughness, for which the staff, in conjunction with Mr. W. S. Hadaway, Jr., engineer of the Hadaway Electric Heating & Engineering Company, of New York City, must be ascribed great

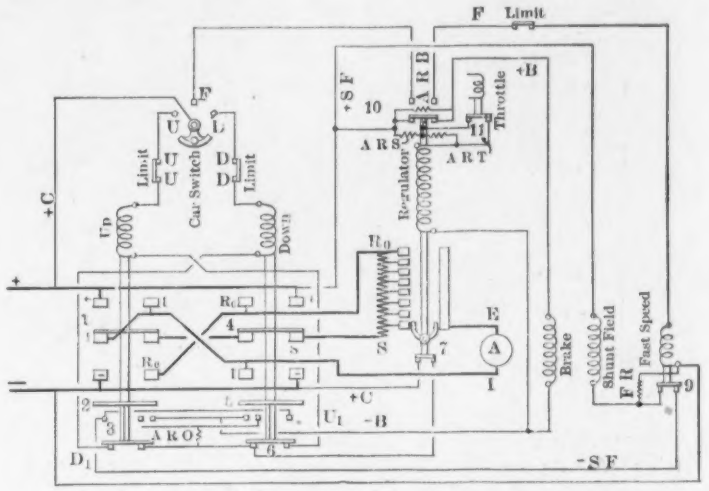


FIG. 25.—DIAGRAM OF MOTOR CONTROL USED ON ELEVATORS.

credit. The uses of electric heat in the office fall broadly into two groups or classes. One of these embraces the foundry and includes matrix drying tables, wax stripping tables, wax melting kettles, case warming cabinets, "builders' up" tool heaters, case warming table, wax knife cutting down machine, "sweating on" machine, and soldering iron heaters. The other class in the bindery includes embossing and stamping press heads, glue heater equipments, glue cookers, case making machines, finishers' tool heaters, book cover shaping machines. This is a remarkable range, but in addition and outside these divisions we find the pamphlet covering machines, the sealing wax melters and some other devices. It is only when one sees such an equipment as has been devised for and brought together in the Government Printing Office that one grasps fully the idea of the extraordinary flexibility and utility of electric heating. Such heating may not yet take care of a big building, but in such special applications as these it cannot be surpassed or equaled for efficiency and economy.

The equipment of these electrically heated appliances in the Office supplants gas and steam in all processes excepting the stereotype melting pots which are heated by gas. Practically all apparatus was made from new designs by Mr. Hadaway with careful attention to mechanical details, and with large factors of safety electrically. The specifications of the controlling appliances were rigid, and necessitated new switch designs giving great strength and durability. The switches, seen on the wall in Fig. 28, are mounted upon slate slabs and protected by iron covers, all connections being soldered to lugs. The slabs are mounted upon iron or slate bases so that every precaution may be taken against accident.

In cases where working temperatures are moderate, the apparatus is operated on 117 volts. Where high temperatures and rapid rates of impartivity are required lower variable voltages are used. These are secured by translating appliances consisting of rotary converters and transformers with several taps on secondaries. The extreme ranges of energy density in various appliances are from 0.75 to 40 watts per square inch superficial area.

The Matrix Drying Tables.—These are employed for preparing the matrices used in printing the *Congressional Record*. The bed is supported upon a massive pedestal to which an apron is attached. The platen is controlled by a heavy double screw in yoke bolted to the pedestal. The bed and apron are heated, each having separate controllers. Great care was necessary to secure a uniform temperature over working surfaces.

Wax Stripping Tables.—After the cases have been used to make electrotype shells, they are put upon the stripping tables which melt

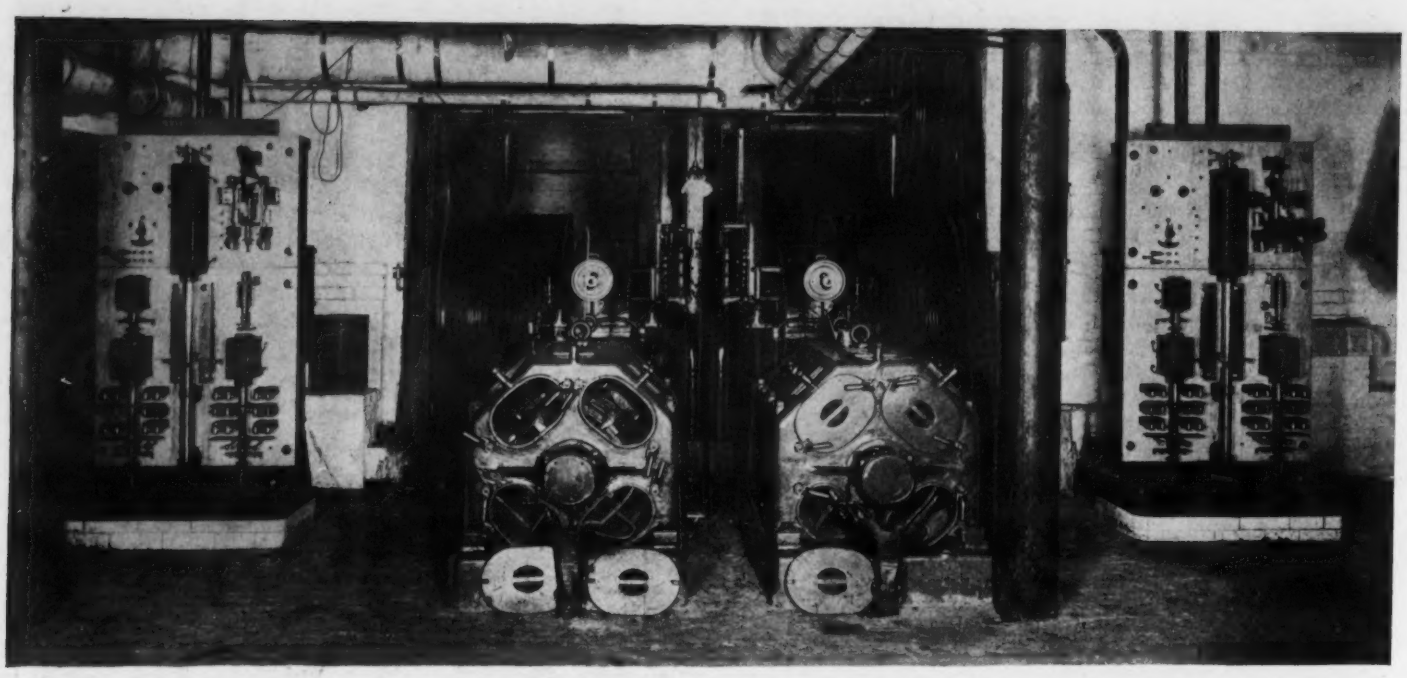


FIG. 26.—VIEW OF DOUBLE ELEVATOR EQUIPMENT.

the wax. The wax is collected in a gutter, which empties into the wax kettles. A variable temperature within moderate limits is desirable according to the amount of work to be done.

Wax Melting Kettles.—The wax is collected in these from the stripping table and freed from graphite and dirt and freshened and tempered. A pair of kettles are placed side by side and attached to a drip pan to facilitate this process. The drip pan is attached to the stripping table on one side and to a pouring table on the other side. The heaters are arranged to give equal temperatures to the walls of the kettles and to prevent scorching and unnecessary destruction of the volatile elements in wax.

Case Warming Cabinet.—Before the cases are put under hydraulic presses, the wax is softened at a moderate temperature so as to give accurate impressions. The warming cabinet is a chamber with racks in which a number of cases may be put to soften the wax. Electric heaters are so distributed as to give a uniformly diffused heat throughout the chamber.

Case Warming Table.—In the case warming cabinet the wax is softened equally throughout. The case warming table is designed to heat the case on the upper surface only so as to secure a firmer backing. A heated plate is placed horizontally above the table upon which the cases rest with the wax films upward. The heating is effected by radiation from a uniformly distributed energy surface.

Wax Knife Cutting-Down Machine.—After the cases have been under the hydraulic presses, the wax is uneven and ragged around the impressions. This machine has a movable bed upon which the case rests. It is then passed under a carefully heated knife, which removes all projections without defacement. This is an instructive example of the greater refinement in processes which has been made possible by electric heating.

FIG. 27.—WAX SHAVER AND WAX HEATING, ELECTRIC HEATING DEPARTMENT.

Builders'-Up Tool Heaters.—Before the case is put in the electroplating bath, it is necessary to build up parts of the surface by melting wax to run upon different points. This is done by heated copper tools. These tools are heated upon hooded electric stoves provided with broad tool supports.

Sweating-On Machine.—In some classes of work, it is more de-

sirable to mount electrotypes upon metal backs than upon boxwood blocks. Stereotype metal blocks of equal thickness are heated upon an electric plate with a film of solder and flux between the block and the electrotype. When the solder film is melted, the block is placed under a light press which cools it under pressure. An electrically heated plate makes this process economically possible owing to equal temperatures over the whole surface, so that several electrotypes may be sweated on to their respective blocks at once.

Soldering-Iron Heaters.—To correct electrotypes and insert new letters, it is necessary to use light soldering irons heated very hot. Electric soldering irons with cords attached had been found unsuitable for this work. Soldering-iron heaters capable of running continually at a high temperature were then adopted. The heat is controlled by varying the voltage. The coppers are inserted in pockets to be heated, each heater having two pockets.

Embossing and Stamping Press Heads.—Stamping and embossing require a variable, uniform temperature in the press heads to increase the production to a maximum. The heads have to be strong and the heaters uninjured by shock. Each press is equipped with a heated head and controller complete.

Glue Heater Equipments.—The glue heaters are inserted flush in the benches. The water bath and glue pot are removable. A cover is provided which leaves the bench smooth for stacking books to be bound when the water bath is taken out and the cover put on. A hook is arranged on the bottom of the heater for alternately holding the cover and the water bath, and the glue pot. The heaters are of minimum heat capacity, and heat by conduction and convection in an insulated chamber.

Glue Cookers.—Glue can be prepared in large quantity in these cookers so that there is no need for the men to waste time waiting to make glue in small quantities. Large kettles are fitted steam tight in a chamber built according to low pressure boiler specifications. The apparatus is supplied with water seal, gauge glass, blow-off valves, etc., complete. The heater is designed for maximum working surface so as to be rapid in operation.

Case Making Machines.—Book covers or cases are rapidly glued together in these machines. A large shallow glue pan is heated by a water bath to which electric heaters are attached. These heaters are in sections for facility of control and temperature regulation.

Book Cover Shaping Machine.—The book covers are rounded at the back by machine so as to be smooth and of uniform appearance. In rounding, as for example, the backs, the glue has to be softened so that the case will retain its proper shape. As the rate of working is fast, a high temperature is necessary to secure the proper relation of heat to speed.

Finishers' Tool Heaters.—In gilding and in burning sheepskin for finishing covers of various patterns, tools of varying sizes and shapes are employed. The temperature range is very great. The maximum is high enough for pyrography, the minimum affords a low heat for gilding. Where pyrographic heat is required, small recessed plates are heated very hot upon which tools of varying design are heated by conduction. These heated plates are controlled by variable voltage. In addition, removable plates are provided to accommodate the several patterns of tools employed. It may be noted that in the branch bindery at the Library of Congress, the heated plates are placed vertically above each other in an insulated chamber, with projecting flanges for supporting handles. Variable temperatures in the chambers are secured by varying the amount of heating surface.

FIG. 29.—VIEW IN ELECTROTYPE FOUNDRY.

Pamphlet Covering Machines.—The pamphlets prepared in infinite number are covered by machines which rapidly glue the backs and place the paper covers on. The backs of the pamphlets are glued by passing over a wheel which turns in a large shallow glue pan.

FIG. 28.—ELECTRIC HEATING DEPARTMENT. FIRST ELECTRICALLY-HEATED MATRIX PRESSES EVER MADE.

The glue pan is of heavy construction and so designed with relation to mass and heater surface as to require no water bath.

Sealing Wax Melters.—These are small heated tools used to melt sealing wax in situ and smoothe the wax so as to prepare it for the seal giving a neat, strong wafer.

Work on this large and unique installation was begun in a conservative way in 1898. Each year, as results became conclusive, small additions in various lines were tried. The sole consideration aside from durability of heating appliances and depreciation factor, was whether a variable controllable temperature increased production sufficiently to pay for the greater cost of the heat required. The answer was in the affirmative, and electric heating appliances have now been used in every process requiring heat excepting the stereotype metal pots.

A great number of heaters are used, and in so large an installation the depreciation of every part of every heater must be considered. Very large factors of safety have been allowed. In high temperature work the energy has been translated to voltages giving maximum mechanical strength to resistances and ensuring effectiveness in operation. This may be likened to the transformations necessary in energy for electro-plating.

An installation representing years of study along this line involves many new features, and it is believed that more attention has been paid to the salient features embodied in this apparatus than in any electric heating installation hitherto made. This treatment of the subject, while it may appear long, is, in fact, very superficial, but is limited by considerations as to the general scope of the present article. As a matter of fact, the electric heating plant of the office is from its novelty and its bearing on a still undeveloped branch of the electrical arts and industries worthy all the space here devoted to the electrical equipment of the office as a whole.

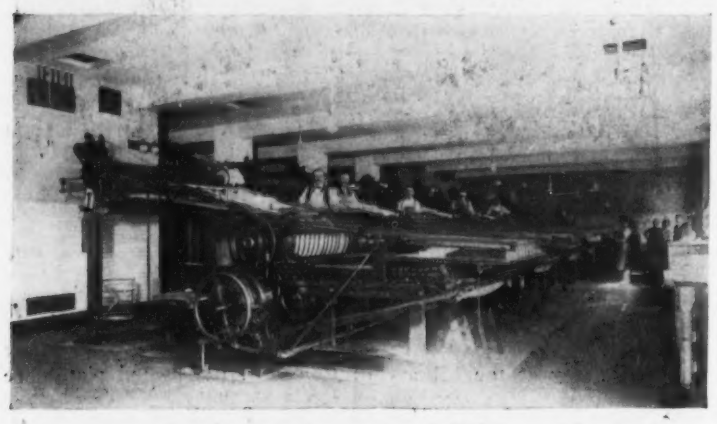


FIG. 30.—A PRESS ROOM SHOWING DISTRIBUTING CENTER AT VENT SHAFT ON WALL ABOVE PRESSES FOR POWER, AND LIGHTING CENTER AT EXTREME RIGHT OF CUT.

Power Signaling on British Railways.

The following from the London *Times* is forwarded by U. S. Consul Mahin, of Nottingham, England: "Three distinct systems of power signaling are now engaging the consideration of British railway managers. These are (1) the all-electric, (2) the electro-pneumatic, and (3) the pneumatic. The first-named system has been adopted by the London & Northwestern Railway at Crewe, and also by the Northeastern Railway Company at its Severus junction box, York, while the Northeastern Railway at Tyne Dock, the Lancashire & Yorkshire Company at its new station at Bolton, and the Great Eastern Railway at Bishopsgate Street goods yard have installed the Westinghouse electropneumatic system. The third system—the pneumatic low-pressure—has been installed on the London & Southwestern Railway, while it is announced that the Northeastern Railway, which has already experimented with the first two named systems, has now arranged for an installation of the low-pressure pneumatic signaling, in order to arrive at the relative merits of the three systems of power signaling on the market. The Great Central Railway Company, which is about to equip its Woodhead Tunnel with the 'Miller' electric signals, has recently placed a contract with the British Pneumatic Signaling Company for the installation of pneumatic signaling in the neighborhood of Manchester."

Annual Meeting of the American Association for the Advancement of Science.

The fifty-third annual meeting of the American Association for the Advancement of Science convened in St. Louis on December 28, under the presidency of the Hon. Carroll D. Wright. After the usual addresses of welcome, the association resolved itself into its various sections to listen to the addresses of the retiring vice-presidents. Prof. E. F. Nichols, the retiring vice-president of the Section in Physics, was unable to be present, and Section B united with Section D, Mechanical Engineering, to listen to Prof. C. A. Waldo, of Purdue University, on "The Relation of Higher Mathematics to Engineering." The essential feature of this address was that calculus should be taught largely through an analysis of its application to practical problems in physics and engineering. In this manner the student had better become acquainted with calculus as a working tool.

The retiring president of the association, President Ira Remsen, of Johns Hopkins University, gave a very scholarly and interesting address on "Scientific Investigation and Progress." He explained how the association was accomplishing its purposes through these migratory annual meetings, where large numbers of scientific men gather for intercourse. This intercourse stimulates thought, the thought leads to work, and the work leads to greater usefulness. He then spoke of the benefits which chemistry is bestowing upon mankind, especially in connection with the raising of food stuffs and the discovery of new medicines and other disease preventives.

On Tuesday and the three following days the several sections listened to the reading of technical and scientific papers by the members. The sections of Physics and of Mechanical Engineering usually have many papers of electrical interest. But at this meeting there seems to have been little of special interest to readers of this journal presented before the Mechanical Engineering Section. Before the Section in Physics, presided over by Prof. E. H. Hall, of Harvard University, there were presented in all thirty-seven papers, about half of which were concerned with electrical subjects. Among the more interesting of these papers the following may be mentioned:

"Iron Losses in Loaded Transformers," by Prof. E. S. Johonnott, of Rose Polytechnic Institute. When a differential coil is added to a Rayleigh phasemeter, it is adapted to the measurement of iron losses in a loaded transformer. It was found that in a transformer having great magnetic leakage, there was an apparent increase in the loss of energy in the iron in the secondary, and decrease in the energy loss in the primary. If a transformer in which there is little leakage has the load in the secondary increased, the loss of energy in the iron and the exciting current and its phase with respect to the induction, remain constant.

"A Simple Alternate-Current Frequency Recorder," by Prof. E. S. Johonnott, of Rose Polytechnic Institute. To one pole of a simple electromagnet is attached a light armature, which is held at some distance from the other pole by a stiff, flat spring. If an alternating current is sent through the coils, it causes the armature to vibrate with a frequency twice that of the current. A smoked-paper recording device may be arranged to receive the trace made by a style attached to the armature, and also the marks from a pendulum or tuning fork. The frequency may then be counted. The current through two incandescent lamps in parallel on 100 volts is sufficient to operate the apparatus.

Another paper was "On the Velocity of Light in a Magnetic Field," by John Mills, of Western Reserve University. The experimenter undertook to measure the acceleration or the retardation experienced by a circular component traversing a magnetic field. The apparatus consisted of a Michelson interferometer. In the path of each beam was placed a tube of carbon disulphide surrounded by a solenoid. The light passed through a Nicol prism and a Bravais double plate. Half of the fringes were thus composed of light circularly polarized in a direction opposite to those of the other half. The formation of a magnetic field produced a shifting of the two sets in opposite directions. The current causing a shifting of one full band (corresponding to a difference in phase of 360°) was observed. On the assumption that the rotation of plane polarized light is the result of a difference of phase between its circular components, the difference of phase corresponding to this value of the current was calculated. It was 368°. The readings for the current giving a displacement of three bands (that is a difference of phase of 1080°) corresponding to a difference of 1101°, calculated.

"A Method for the Determination of Mutual Induction Coefficients," by Augustus Trowbridge, of the University of Wisconsin. If a pair of coils are joined in series and are so placed that the magnetic tubes of force of one thread through the other, the self-induction of the pair is $L_1 + 2M + L_2$. Upon reversing the current through the coil, the self-induction is $L_1 - 2M + L_2$. The coefficient of mutual induction, M, may be found by measuring the two quantities mentioned by means of a bridge method.

"On the Electrical Resistance of Hydrogen-Charged Palladium," by Prof. W. E. McElfresh, of Williams College. This paper will appear in full in the *Transactions* of the American Academy. "A Remarkable Distribution of Carbon on the Bulb of a 'Hylo' Incandescent Lamp," by Prof. Arthur L. Foley, of Indiana University. On the bulb exhibited there are peculiar band and ring deposits, which are dark and of uniform density, while the other portions of the bulb are perfectly clear, the line of separation being as clear as though laid on with a brush. The theory of molecular shadows and the "Edison effect" explains the general character of the deposit, but does not explain the peculiar shapes and the sharp outlines. An attempt to age a number of similar lamps by subjecting them to a high voltage, a uniform deposit quite unlike them are described.

"On the Use of Nickel in the Case of the Marconi Magnetic Detector," by Prof. Arthur L. Foley, of Indiana University. The various forms of sensitive detectors of recent construction were described, and the effect of varying proportion of nickel in the Marconi form was considered.

"On the Charges Given to Surfaces by the Diffusion of Ions, and the Earth's Negative Potential," by Prof. John Zeleny, of the University of Minnesota. Experiments were made showing neutral ionized air in passing through a long tube at first gives a negative charge to the tube, and farther along it charges the tube positively. If the tube is short, only the first effect is obtained, the air itself coming out with a positive charge. Dry carbonic acid gave the same effects, while saturating the gas with water vapor caused phenomena with reversed sign. The results are explained by supposing the charges to be produced by the unequal rates of diffusion of the two ions. These experiments confirm Geitel's explanation of the earth's negative potential.

"On the Differential Telephone," by Prof. William Duane, of the University of Colorado. Two separate coils are wound on the bobbin of a telephone receiver; there are adjusted to have equal resistances and equal self-inductances, and so that their magnetizing effect is zero when equal currents pass through the coils in opposite directions. The coil whose self-inductance is to be measured is connected in series with one coil, and a variable standard of self-inductance in series with the other. A non-inductive resistance is connected to that series having the least resistance, and the two series are connected in parallel and an alternating e.m.f. is applied to the branch points. It will be possible to adjust the several factors of the circuit so that the sound in the telephone vanishes. The unknown self-inductance may be determined to one part in five thousand.

"A Continuous Method of Steam Calorimetry," by Dr. Joseph H. Hart, of the University of Pennsylvania. The continuous method of steam calorimetry here outlined is capable of measuring readily latent and specific heats of fluids with a degree of accuracy seldom attained by other methods, even though they be made with the greatest refinement in the method and observations. If a stream of water at a temperature of T_1 be passed through a worm immersed in a steam bath and emerges at a temperature T_2 the quantity of heat absorbed is $m\ S\ (T_2 - T_1)$, where m is the mass of water passed through and S the mean specific heat of water between T_2 and T_1. If the heat absorbed by the water is obtained by direct condensation of steam alone we have the equation:

$$M\,L = m\,S\ (T_2 - T_1).$$

Where M is the mass of the condensed water and L the latent heat of condensation of steam. If either L or S is taken as known, the other may be readily obtained. Barnes' values of S were taken and a number of determinations of L made to test the efficiency of the method. In the practical development of the method, the process was made continuous. The water in the worm and the condensed water was drawn off constantly and measured. Radiation and conduction entered as important factors in the construction of the calorimeter, but were eliminated or at least satisfactorily accounted for in the amount of condensed water, both by theory and practice. Results were obtained in consecutive experiments, which were concordant to the fifth significant figure.

Perhaps the most interesting event of the meetings was a popular lecture on "Radium and Radioactivity," by Prof. E. Rutherford, of McGill University, Montreal. He had given two scientific papers before the Physical Society, in which he described some new and important phases of his researches on the properties of radium. In his popular lecture he described and illustrated these discoveries, besides giving a general account of the discovery and properties of radium. A golf-leaf electroscope was arranged for projection, and with this the discharging effect of radium was strikingly exhibited, the sample of radium used being thirty milligrams of pure radium bromide. The interposition of a plate of iron two inches thick only slightly reduced the effects. It was demonstrated that when radium is heated there is liberated an emanation which, when conducted through a tube to the electroscope, the latter is discharged. Prof. Rutherford described a differential air calorimeter with which he had verified Prof. Curie's discovery that a gram of radium gives out heat at the rate of a hundred calories per hour. He has proven that this energy resides in an emanation which may be driven off by heating, and which can be condensed by liquid air. This was demonstrated upon the stage. This emanation seems to possess all the energy, and leaves the radium without energy. The emanation seems to be gaseous, possibly is helium, and can be preserved by itself. It gradually loses its energy, while the inert radium regains its former activity. These changes proceed in a geometrical progression, the recovery being about one-half in four days, with a practically complete recovery in a month. It was computed that one gram of radium gives off 6×10^{-6} cubic centimeters of emanation; and that a pound of this emanation would be able to give out energy at the rate of 10,000 hp for six days, an amount sufficient to drive a steamer across the Atlantic. It was suggested that radium might prove useful in the treatment of cancer and of consumption, though at present there is little definite information upon these points. The lecturer referred to the undoubted presence of radium in the earth and in the sun, and suggested that Lord Kelvin's "distressing theory" that the sun's heat would be exhausted in 60,000,000 years might be disproved; and that it might possibly be the presence of radium in the soil which causes an increase of temperature towards the center of the earth. The experimental parts of the lecture, involving the use of the lantern, the induction coil, liquid air and much accessory apparatus were very successful. The entire audience was able to see the luminosity of the radium itself, and its induced radioactivities on various mineral substances. An artificial "spinthariscope" gave a vivid impression of the wonderful sight exhibited by this small instrument.

The American Physical Society held its annual meeting in connection with the association. Twelve papers were read before the society, several of which are mentioned above. The president was Prof. A. G. Webster, of Clark University, who was re-elected president for the coming year.

Among those elected Fellows of the Association (the highest grade of membership) are E. S. Johonnott, professor of Electrical Engineering in Rose Polytechnic Institute; Henry Crew, professor of Physics in Northwestern University; A. S. Langsdorf, professor of Electrical Engineering in Washington University; C. M. Knight, profesor of Physics in Buchtel College, and Bernhard A. Behrend, of Cincinnati, member of the American Institute of Electrical Engineers.

The number of members registered at the meeting was 385; this number does not, however, fairly represent the attendance, for the many affiliated scientific societies were attended by other scientists not included in the above. The attendance at the sessions of the Physics Section was usually about 75. While the Middle West was very adequately represented, there were many prominent members in attendance from the East and New England, as well as from the Pacific coast. Upon the whole, the meeting was very successful, and it was enjoyable and profitable for all present. The local committee of St. Louis provided a most hospitable entertainment for their guests, which was duly appreciated. One afternoon the whole association visited the World's Fair, as guests of the management. After a lunch the members inspected the spacious grounds and the many beautiful buildings now nearing completion.

The next meeting of the asociation will be held in Philadelphia, beginning December 28, 1904. Prof. W. F. Magie, of Princeton, will preside over the Section in Physics and Prof. D. S. Jacobus, of Stevens Institute of Technology, will be the presiding officer of the Mechanical Engineering Section. It is thought that the meeting for 1905 will be held in New Orleans.

Gas Power for Central Stations.

At the December meeting of the American Institute of Electrical Engineers, Mr. J. R. Bibbins in a paper entitled "Gas Power for Central Stations," discussed the operation of electrical generating stations in connection with gas works, and presented in the form of curves and tables much interesting data relating thereto. Owing to limitations of space we are obliged to omit the tabular matter, which is, however, available for reference in the *Transactions* of the Institute.

In opening Mr. Bibbins stated that his object was to offer evidence that present gas-power machinery is suitable for central station service; that a well-equipped gas-power electric plant can operate with far better economy than a steam plant under similar conditions; that its operation is much simpler and requires less running expense for the same results; and that gas works laboring under low load or output factor, can profitably install a gas-power electric generating station, and become its own largest customer, selling both gas and electricity at comparative rates.

The basis of the paper consists of data collected from various electric light and power plants in the United States using gas engines as their principal motive power, a number of which are operated by gas companies.

Tables accompanying the paper gives the data of 15 plants. Of these 12 are located in centres ranging from 2,000 to 25,000 population, and where in most cases the cost of fuel is high. The equipments average 315-hp capacity, and operate a variety of types of generators for arc and incandescent lighting and for railway or general power service. All the generators are belted, the majority directly, but a few through the medium of a jack-shaft, the latter arrangement being employed in order to obtain the desired flexibility of service without installing a number of engines of small size. The other three plants are somewhat larger and generate polyphase power for industrial works. These three plants average approximately 570 brake hp and the units are all direct-connected and run in parallel.

In general, the character of electrical equipment is not all that could be desired for furnishing results of great accuracy; but owing to the more or less uncertain calorific value of the fuel-gas used, errors of a few per cent. in particular cases will not have much effect upon the general result. In any event, the average cost of power charged against the station is the desired figure.

A 65-hp two-cylinder vertical engine of the type employed in the plants reported on has made the following record in fan-blower service: In a period of 8,472 hours, the stoppages were 242 hours, or 3 per cent., 0.6 per cent. of which was chargeable to the engine in changing igniters and setting up bearings. During this period the engine ran, without stopping, 1,157 hours, and was then shut down to repair a broken belt.

In a pumping station located on the Allegheny, a short distance from Pittsburg, five 85-hp engines of the same type operate regularly at full load through the week without stopping, except on Sunday, when the units are shut down in rotation for inspection and repair. Each engine operates from 96 to 98 per cent. of elapsed time. Such service would not be required in central stations, as reserve capacity should be available for use during peak-loads. In the present exhibit, the majority of the plants operate from 18 to 22 hours per day, giving ample time for inspection and repair, even if no reserve capacity were provided.

The skill required for operating a gas plant is apparently no greater than for steam plant. In several instances where the latter have been replaced, the old employees have been retained. In newly established plants steam engineers have invariably taken charge after short preliminary instruction from the builders' erecting engineer.

In one plant weekly inspection of bearings, igniters, and valves were at first carried out. This was found to be unnecessarily frequent and is now done once a month. The cylinders are inspected occasionally throughout the year. This plant, 800 hp capacity, is operated by three day men and one night man, ten hours to a shift.

In cost, the gas-engine equipment is quite comparable with that of a steam plant. The engine itself costs more than a steam engine of corresponding size, on account of the increase in metal required by the higher pressures dealt with. With the cost of condensing machinery charged to the steam-engine, however, this disparity is much reduced. With natural or illuminating gas supply available, the equipment cost would fall considerably below that of a steam equipment of boilers, engines, condensers, heaters, pumps, etc. In the case of a producer gas plant installed to supply the gas engines, the cost of the respective equipments, each of 1,000 hp, is at a parity, although depending somewhat upon the gas storage capacity provided. This, however, amounts to much less than electric storage. For producer gas the former costs in the neighborhood of $7.35 per hp hour and the latter $100. Considering the increase in productiveness of labor which is stated by a prominent gas engineer to be fully 100 per cent. (owing to the fact that one man can handle twice the amount of coal), the advantage, if any, held by the steam plant, disappears.

In economy of fuel, the gas engine admittedly has no rival. The present limit of steam engine practice is 10 pounds water per ihp, or 11 pounds per bhp. With an evaporation of 10 pounds of water per pound of good coal (14,000 B.T.U. per pound), a performance of 1.1 pound coal, or 15,400 B.T.U. per brake hp is realized. The gas engine at present delivers, at full load, a brake hp upon 10.5 to 11 ft. of gas (of 900 to 1,000 B.T.U. per cu. ft., calor$_1$ic value) which is equivalent to 10,000 to 11,000 B.T.U. per brake hp; Fig. 1 shows a typical test-log upon a 550-hp engine of the three-cylinder vertical type, employing the four-stroke cycle. The thermal efficiency shown is the true or "kinetic" efficiency, namely, the ratio of the input to the output, or the thermal equivalent of the work done to the thermal value of the gas.

At full load this appears at 25 per cent., and considering that the theoretical limit of gas engine efficiency is yet only approached, and the fact that the theoretical efficiency of a steam engine working

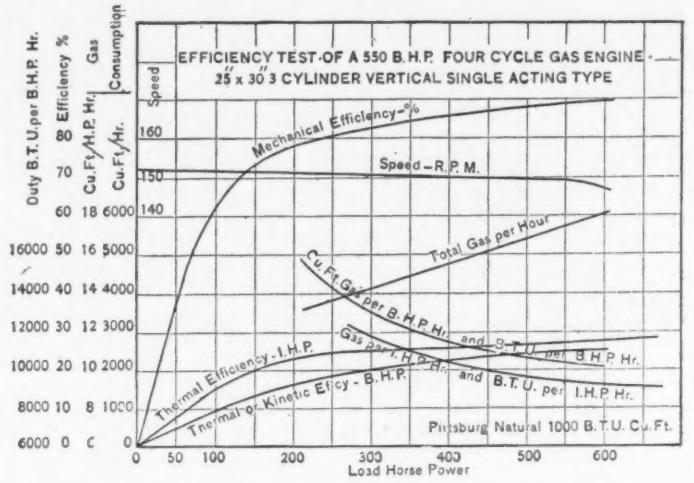

EFFICIENCY TEST OF A 550 B.H.P. FOUR CYCLE GAS ENGINE
25" x 30" 3 CYLINDER VERTICAL SINGLE ACTING TYPE
Duty B.T.U. per B.H.P. Hr.
Efficiency %
Gas Consumption
Cu. Ft./H.P. Hr.
Cu. Ft./Hr.
Speed
Mechanical Efficiency—%
Speed—R.P.M.
Total Gas per Hour
Cu. Ft. Gas per B.H.P. Hr. and B.T.U. per B.H.P. Hr.
Gas per I.H.P. Hr. and B.T.U. per I.H.P. Hr.
Thermal Efficiency - I.H.P.
Thermal or Kinetic Efcy - B.H.P.
Pittsburg Natural 1000 B.T.U. Cu. Ft.
Load Horse Power

FIG. 1.—EFFICIENCY CURVES OF FOUR-CYCLE ENGINE.

between the usual units of 150 lbs. boiler and 3 lbs. condenser pressure has already been exceeded, there appears to be an encouraging future for internal combustion motors.

Mr. Bibbins summarizes the advantage of the gas engine for central stations as follows:

1. Minimum fuel and heat consumption. 2. Light load efficiency higher than steam engine of corresponding size. 3. Low cost of operation and maintenance. 4. Simplification of equipment. 5. Small number of auxiliaries required. 6. Absence of "standby" losses. 7. Quick starting. 8. Waste heat in jacket water suitable for building heating. 9. Ease of extending equipment. 10. Absence of high pressure except in engine cylinder. No danger from explosion outside, as a mixture of proper proportions is required. 11. Power can be stored during light loads at small cost in the form of gas in holder. 12. Sub-division of units more easily accomplished, yielding higher all-day economy.

An important source of economy in gas plants is the fact that as soon as an engine is shut down all heat losses cease. Also, during operation no heat is lost by the gas in transit from the producer, and the plant is not hampered by inefficient auxiliaries such as steam pumps, condensers, return traps, etc., all of which largely increase the general complexity of the system. Steam pipe and cylinder condensation losses, radiation, leakage in piping, and fuel loss in banking fires, have no parallel in the gas plant. The only auxiliaries required are the igniter generators, and air compressors. The former are negligible as affecting the economy of the station, and the latter operate at full capacity at regular intervals. In cases where artesian wells supply jacket water, a pump is of course required, preferably operated by a motor or small gas engine to which the air compressor may also be belted.

In quick starting, the gas engine fulfils every requirement. The 280-hp pumping units of the Philadelphia high pressure fire system have been repeatedly started cold, brought up to speed and the pumps loaded to the required pressure (300 lbs. per sq. in.) within a period of 40 seconds from the starting signal. In another plant employing 133-cycle high-speed generators, the units are regularly started in two minutes, and this may be reduced to one minute in case of necessity.

A number of plants make use of hot jacket water for heating offices and buildings, ordinary cast-iron or coil-pipe radiators being used for this purpose. One station partly supplies a municipal heating system resembling the Yaryan, thereby deriving direct revenue from a waste product. Part of the return water is sent again through the jackets, the temperature being lowered to the proper degree by adding fresh water from the station supply main. Another station returns hot jacket water to a large cistern where it partially cools and is again pumped through the jackets emerging at a temperature of 200° F. before being discharged into the sewer. As return water from a heating system is also discharged into this well, a small amount of cold water from artesian well or city water system is added from time to time, to reduce the general temperature of the circulating system. In another plant, the jacket water is utilized in winter for warming the water in the gas holders to prevent freezing. This was formerly done by using live steam from a boiler used in making water gas. It is estimated by the manager that a saving of $250 per year is effected. In locations where water is expensive, a small cooling tower may profitably be installed to cool the jacket water which may then be saved.

In the matter of parallel operation of alternating-current generators, the three larger plants noted have been distinctly successful, particularly in view of the variable character of load incidental to large industrial works operated by induction motors. All the units are of the direct-connected type with standard fly-wheels. A spring coupling provides a flexible connection between engine and generator, to absorb cyclical speed variations. The usual copper dampers on the pole pieces assist in preventing hunting. In general, a low frequency seems to be desirable, with high peripheral speed and moderate reactance in the generator to assist in damping current fluctuations. The suddenness of the impulse in a gas engine cylinder offers, to be sure, greater difficulties than in the case of a steam engine, but the remedy has apparently been found.

The following table is given of the calorific values of different gases suitable for gas engine use. The first column gives the calorific value in B.T.U. per cubic foot for the gas itself and the second column the calorific value for the working mixture:

Natural gas	1000	91.0
Coal gas	650	91.7
Water gas	300	88.0
Carburetted water gas	600	92.0
Producer gas	120 to 145	60 to 68
Coke oven gas	600	90.0
Blast furnace gas	90	53.0

The power to be developed by an engine of given proportions does not therefore vary within appreciable limits, except on producer gas and blast-furnace gases, when larger engines are required, or larger cylinders on the same engine frames. The rate of combustion is, however, less rapid with these than with other gases due to the large amount of inert gases such as nitrogen and carbon dioxide present in the mixture. The compression may also be carried much higher without risk of pre-ignition, or "back firing," thus increasing the efficiency of the cycle. With water gas the high percentage of hydrogen occasions quicker combustion and higher flame temperatures with so considerable a tendency to pre-ignition and back firing that this gas is not well adapted to gas engine work.

In water-gas plants a great saving may be made and the gas rendered much more suitable for the operation of gas engines by providing additional holders for the air or blast gas made during the period when the producers are under blast. This gas is equivalent in calorific value to blast furnace gas—90 B.T.U.—and is generally allowed to go to waste. It may, however, be used to great advantage for power purposes, either alone or mixed with a proportion of water gas which it renders less snappy and thereby better suited for use in gas engines. In fact, by this means a gas is obtained similar in many respects to the producer gases made by operating a producer continuously with combined steam and air blasts.

Leaving out of consideration the by-product, or waste coke-oven and blast-furnace gases, as occupying a field of power development somewhat foreign to the subject in hand, producer gas offers at present the greatest possibilities in the field of power for use in manufacturing centres. This is due to its comparative cheapness, simplicity of installation and general efficiency when gas for power purposes is alone considered.

A comparison of the approximate thermal efficiencies of the various processes gives the following results.

Coal gas (without coke)	24%
Coal gas (with coke)	60%
Water gas	60%
Water gas, special quick blast	75 to 80%
Producer gas	80 to 85%

Assuming the calorific value of coal as 14,000 B.T.U. per lb. and the efficiency of the gas-making process 80 per cent., the heat available at the engine is 11,250 B.T.U., which is equivalent to about one bhp. This duty, one bhp per lb. of coal, should therefore be expected from a well-equipped gas-power plant.

The average gas consumption of the stations reported was 39 cu. ft. per kw-hour. In some cases the averages were given for several months' operation, so that the results represent the efficiency of the entire station, day in and day out, with various generating outfits running at varying load factors, and including errors of measurements encountered in every-day operation. Although in some cases "over-dynamoed," the engines are generally underloaded and frequently so much so that good economy could hardly be expected. The average gas consumption per kw-hour is 39.0 cu. ft Assuming an average calorific value of 625 B.T.U. per ft. for coal gas, water gas, or mixed gas, the heat consumption is 24,000 B.T.U. per kw-hour, 18,200 B.T.U. per electric hp-hour, and 14,500 B.T.U. per brake hp-hour. The average cost of gas charged to the engine is 33.9 cent per M, which is in nearly all cases considerably above the cost in the holder to companies operating both plants, with the result that the gas works realizes a handsome profit from the electric station in addition to the decrease in cost per unit with increased production. This point will be brought out later. Assuming an average production cost of 20 cents per M, the average cost of power is 0.83 cents per kw-hour, equivalent to .0495 cents per brake hp-hour at 80 per cent. combined efficiency.

The comparative cost of steam with gas power is illustrated in two tables. In one two independent stations were operated during 1902, together with the gas works. The cost of coal in the steam plant was 1.38 cents per kw-hour against 0.75 cents per kw-hour in the gas plant, representing a saving of 45.5 per cent., although the cost per M B.T.U. of gas was 3.4 times that per M, B.T.U. of coal. Assuming calorific values of 14,000 and 625 B.T.U. per lb. and cu. ft. respectively, 92,000 B.T.U. were required per kw-hour in the steam station, against 29,100 in the gas station, or a saving in the latter of 68½ per cent. of the former.

In the other table the output was not measured, but the costs indicate the general balance of economy on the side of the gas station. The steam plant started operation on natural gas at 10 cents per M with a minimum of $3,000 per year. It employed boilers fired by gas. One year after starting the gas plant, this minimum was reached and the company is now paying at the rate of over 16 cents per M ft. The saving in total operating cost amounted to 405 per cent. In the face of a 30 per cent. increase in station output, the gas consumption has been reduced by 93 per cent. Previous to the replacement of the steam equipment an economy test was run on the station, throughout 24 hours. The gas consumption at the boilers was 51.09 cu. ft. per ihp, developed at the engines, equivalent to about 86 cu. ft. per kw-hour. All engines were of the simple, high speed type running non-condensing. During the six months ending August, 1902, the total gas consumption of the station, including heating, was 23.8 cu. ft. per kw-hour. Deducting approximately 7.5 per cent. for heating, the net consumption was 21.5 cu. ft., which is about 24 per cent. of that recorded on the steam station. It is equivalent to 12 cu. ft. per brake hp, or a duty of 14,100 B.T.U. per brake hp.

The gross station economy in the case of one plant is shown on curve sheet No. 1. These observations were taken when the station was first started and operating under an extremely low load-factor.. Curve sheet No. 2 shows similar results from another station, which also operates considerably under rating. Both sheets show the decrease in cost of gas at the gas works, due to the increase in works output, necessitated by the electric station. The results may be considered as representative of conditions about as unfavorable to high economy in the prime mover as is usually encountered. Another table gives the operating cost of a plant for six months, during 1902. The average cost of gas is 1.22 cents per kw-hour, and the

total operating cost 3.18 cents per kw-hour. Considering this to be a plant of but 135 hp, these results are good.

The above data show in a general way the results that may be accomplished by gas-power plants, even though running under a burden of expense for fuel that would be quite out of the reach of steam plants. It goes without saying that much better results are obtainable in a plant of considerable size of modern design and furnished with reasonably cheap fuel gas.

Combined Gas and Electric Stations.—The theory of increase of profits from the operation of combined gas and electric plants is based upon the fundamental principle of reduction in cost per unit with increased output. If the net saving is sufficient to cover fixed charges upon the electric station, the way is clear to reap a double

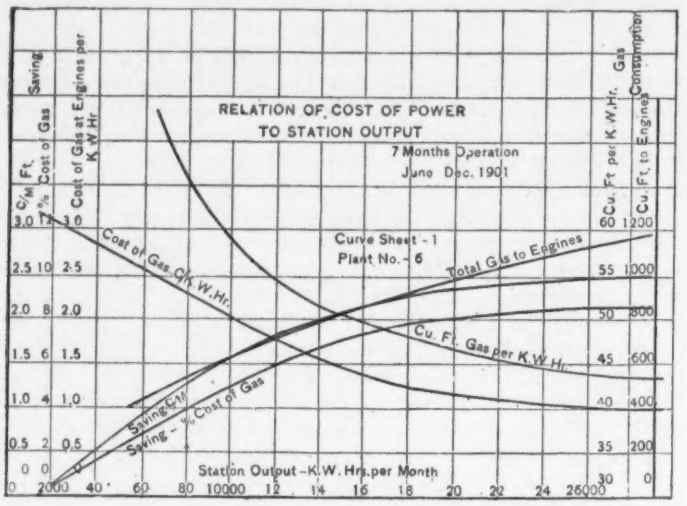

RELATION OF COST OF POWER
TO STATION OUTPUT
7 Months Operation
June Dec. 1901
Curve Sheet - 1
Plant No. - 6
Cost of Gas C/K.W.Hr.
Total Gas to Engines
Cu. Ft. Gas per K.W.Hr.
Saving C/M
Saving - % Cost of Gas
Station Output - K.W. Hrs. per Month
Saving
Cost of Gas C/M
% Cost of Gas
Cost of Gas at Engines per K.W.Hr
Cu. Ft. Gas per K.W. Hr.
Gas Consumption
Cu. Ft. to Engines

FIG. 2.—RELATION OF COST OF POWER TO OUTPUT.

revenue, one from the electric station operating at a cost far below its steam-driven competitors, and the other from the gas station operating at a lower cost of production than before. The balance may, of course, be applied proportionately to the disbursement of fixed charges on both stations. It is usually the gas station that reaps the profit at the expense of the electric station. An adjustment of gas and electric rates can easily be made to prevent embarrassing competition.

Curve sheet No. 3 shows the cost of coal gas, water gas and mixed gas for approximately 500 gas plants in the United States, from the report o fthe Commission of Labor on Gas and Electric Plants, 1899.

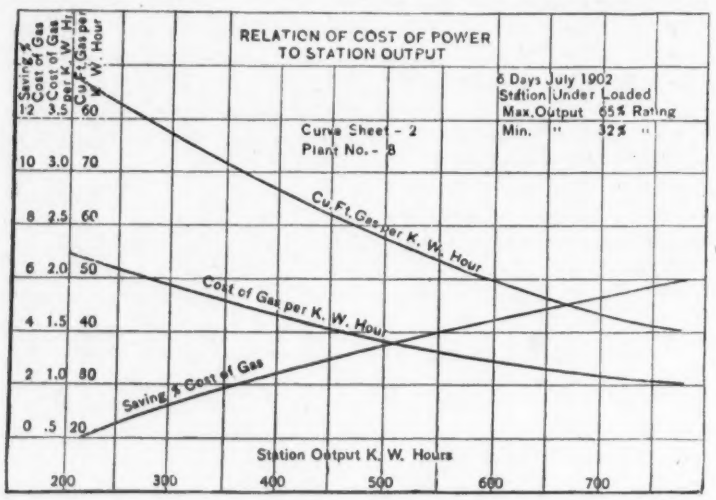

RELATION OF COST OF POWER
TO STATION OUTPUT
6 Days July 1902
Station Under Loaded
Max. Output 65% Rating
Min. " 32% "
Curve Sheet - 2
Plant No. - 8
Cu. Ft. Gas per K. W. Hour
Cost of Gas per K. W. Hour
Saving % Cost of Gas
Station Output K. W. Hours
Saving %
Cost of Gas per K. W. Hr.
Cu. Ft. Gas per K. W. Hour

FIG. 3.—RELATION OF COST OF POWER TO OUTPUT.

The curves were determined by the method of moments from a "shot-gun" diagram, and bring out the following points:

1. Cost per unit decreases as output increases, most rapidly in coal-gas plants and less rapidly in water-gas plants.

2. Decrease in cost per unit in small plants of two to ten million per year output is very marked, being greatest in water-gas plants and least in mixed-gas plants.

3. The greatest opportunity for increasing revenue from combined gas and electric station appears to be in the case of small coal and water-gas plants under ten million output. The smaller the plant, the greater the profit.

Curve sheets 4 and 5 represent the saving due to increased production, part of which is traceable to the electric plant and part to consumers. In one plant a saving of 24 per cent. was realized, and in

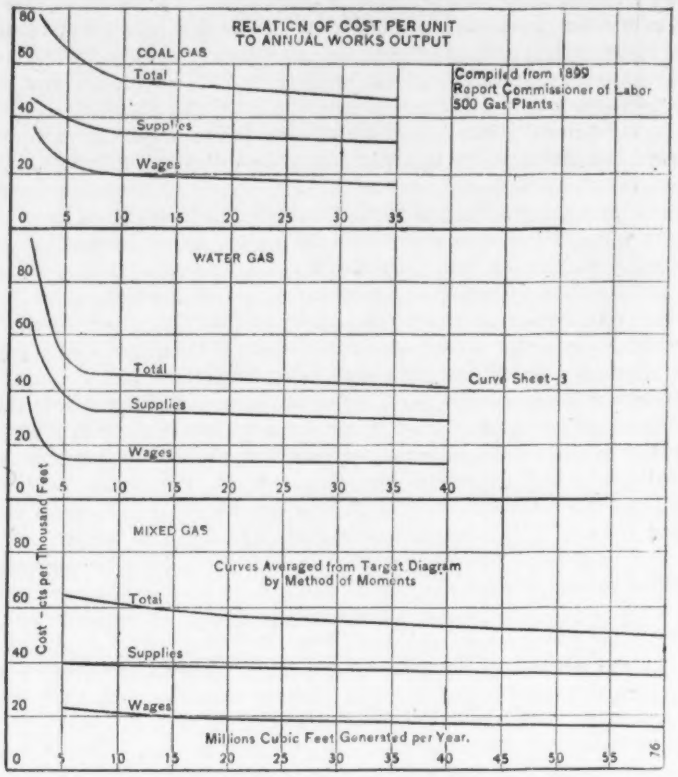


FIG. 4.—RELATION OF COST PER UNIT TO ANNUAL OUTPUT.

still another the remarkable amount of 92 per cent. of initial works cost.

In order to bring out clearly the character of this saving due to increased production, the following case has been estimated along the lines indicated in the preceding paragraph. A ten-million-foot plant has been taken generating gas at 40 cents per M- works cost including coal, bench fuel, labor, repairs, and miscellaneous material, residuals not deducted. Fixed charges have purposely been omitted. The gas is charged at works cost to the electric station. It is assumed that the cost of gas for this plant, previous to absorption of the electric plant, was 50 cents per M, and that the electric plant gen-

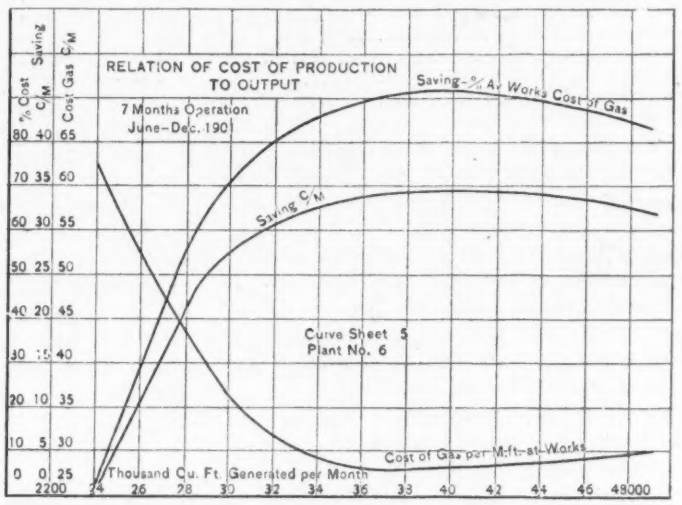


FIG. 5.—RELATION OF COST OF PRODUCTION TO OUTPUT.

erates electricity at twice the fuel cost, 3.2 cents per kw-hour. During normal operation with an output to the electric plant of 30 per cent. of the total amount of gas generated, the total net revenue of the combined works was about $13,300; 45 per cent. of which was due to the electric station and 55 per cent. to the gas station. The operating costs will then amount to 46.4 per cent. of the net revenue.

The comparative market prices for fuel in the case of ten of the above plants averaged $3.63 and $5.10 f. o. b. works for coal and coke respectively, under normal conditions. The corresponding prices during 1902 averaged $4.50 for coal and $7.41 for coke, or an increase of $0.87 and $2.41 over normal for coal and coke respectively.

Comparing the operations of the gas station *per se*, previous to and following the acquisition of the electric station, there is a net revenue of $5,835 and $7,344 respectively, or an increase of $1,509; 25.8 per cent. of the original revenue. Figuring in the saving of 10 cents per M, due to increased production, the total increase amounts to 43 per cent. of the net revenue upon the original gas station.

Considering, finally, the combined works, the increase is $7,449, or 127 per cent. of the original revenue, and adding again the saving 10 cents per M, the total increase is 145 per cent. of the revenue of the original gas works.

Although these percentages will be considerably reduced by the consideration of investment charges, depreciation, sinking fund, etc., the fact remains that the saving due to combined operation is material and should appeal particularly to companies operating independent gas and electric generating stations.

The paper includes an elaborate estimate of the operating cost of a typical gas-electric works having a yearly output of 10,000,000 cubic feet of gas, and supplying customers at $1.25 per 1,000 cu. ft. for gas, and selling current at an average rate of 12 cents per kw-hour. This is followed by ten tables, as follows: Tables giving the data of 15 gas engine electrical generating plants and the cost of operation of eleven of these; comparative operating economy of a 1,250-kw. steam and 685-hp gas engine station; comparative cost of operating steam and gas engine stations on natural gas; operating cost of a 5,000-kw. gas engine station; details of profit from combined operation of a gas engine station and gas works; reduction in cost per unit with increase of production; comparative cost of gas as affected by production; full costs and prices paid for residuals; gas works yields.

A lengthy discussion followed the reading of Mr. Bibbins' paper. Mr. Mershon said that if the paper was intended as a comparison be-

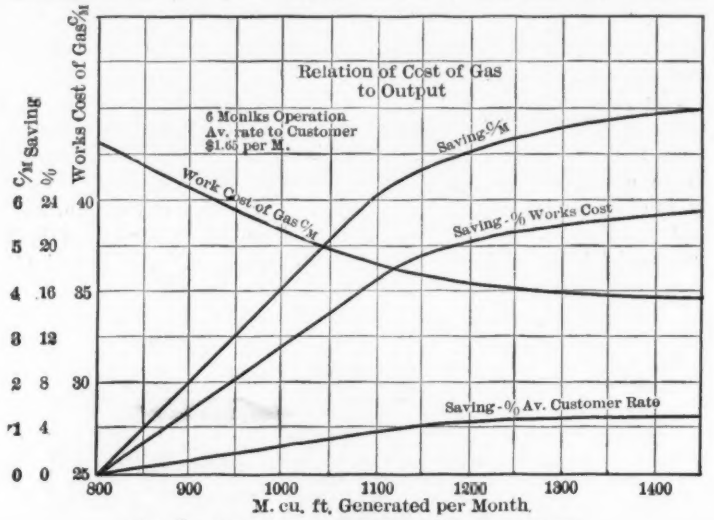


FIG. 6.—RELATION OF COST OF GAS TO OUTPUT.

tween gas and steam plants, he thought some figures should be given for gas engine installations in connection with gas producers, in comparison with figures for steam plants, taking into account not only economy of fuel but the other charges that should be made, such as deterioration, repairs and interest on investment. He considered that if this had been done the figures would not be so highly in favor of the gas engine, although he was thoroughly a friend of the gas engine, and believed the time was not far off when gas engines and gas producers would be installed instead of steam engines and steam boilers, which state of affairs has already arrived in some other countries. In Germany a great many gas engine plants, including producers, have been installed instead of steam engines, but thus far confined mainly to small plants. In some of these plants an interesting type of producer is used, which is operated on what is known as the "suction principle," the gas engine drawing its charge through the producer; the air in passing through the hot fuel forms a gas, and thus gas is generated only as fast as the engine requires it. Mr. Mershon said that he has seen a number of these plants operating very successfully. The police regulations in some cities do not allow the operation of ordinary gas engine plants, but allowed the installation of the type referred to for the reason that the pressure in the generator and pipe system is lower than on the outside, and there is thus no chance for the leakage of gas. He criticised the statement that the cost of a producer gas engine plant of 1,000 hp is about the same as that of a steam plant of the same size, stating that the cost of the gas plant is considerably above that of the steam plant, and when compared with the steam turbine plant the disparity is much greater. He also disagreed that the cost of operation and maintenance of gas engines is less than of steam engines; from some observations he had been able to make, the cost of maintenance of gas engines is higher. As regards the cost of operation, the gas engine requires a better class of operating attendants than the steam engine. Referring to the table of the calorific value per cubic foot of explosive material, Mr. Mershon said that in European practice the calorific power of the various mixtures employed in the gas engine cylinder is much more equal than shown in the table. In conclusion, Mr. Mershon said that the prices now asked by American manufacturers for large gas engine units are out of all reason as compared with the corresponding price of steam engines, and as compared with European prices.

Mr. Bibbins, in replying to Mr. Mershon, said that fixed charges were excluded for the reason that the idea of the paper was simply to bring out the decreased cost of gas to the gas station due to increased production. He said that he had just been informed by a prominent gas engineer that the comparative cost of gas and steam plants with a fair amount of holder capacity, for the former is about as $125 to $100. Plants on the general suction principle not provided with holders involve the risk of gas of non-uniform quantity in the cylinders. It has been noticed that while at the start quite an intelligent class of attendants is necessary for a gas engine plant, after it has been in operation for some time this does not hold. In the plants referred to in the report the steam engineers have been retained. Mr. H. A. Wagner said that it had recently been his sad duty to replace with a steam plant a gas-engine plant which had been operated for several years by a gas company. There had been three 100-hp alternating units, and the cost of operation became so excessive and increased so greatly from year to year that the gas engine was abandoned in favor of the steam engine. During the last year of operation of the gas engine the cost of producing current was something over 8 cents per kw-hour. The largest single item was that of repairs and maintenance. The engines, however, were not of the latest type manufactured, and doubtless the more modern engines would do much better even after having been operated some years. The experience of this company, however, shows that it is even now a question with gas companies whether it is more economical to install gas engine plants or steam plants. The company in question was using water gas largely and consequently it was necessary to provide a separate producer plants for the gas engines.

In reply to a question concerning the operation in parallel of gas engine driven generators, Mr. Bibbins said that the spring coupling seems to solve the problem to some extent. By means of flywheels of moderate size and spring couplings, generators in each of the three large plants considered in his paper have been able to run under all kinds of load, fluctuating as well as steady loads. The largest of the three plants operates cranes and shop motors, and though the load fluctuates within 100 per cent. almost instantaneously, no difficulty seems to have arisen in operating in parallel.

International Electrical Congress at St. Louis.

We are informed that the State Department at Washington, in response to solicitation from the Director of Congresses at St. Louis, and the President of the American Institute of Electrical Engineers, as well as the Committee of Organization of the Congress, has issued instructions, on December 17, to the American diplomatic officers abroad that they shall invite the various foreign governments to appoint official delegates to the International Electrical Congress of St. Louis in September, 1904. The number of delegates requested to be appointed by each country is in conformity with the precedents established at the Chicago Congress of 1893 and at the Paris Congress of 1900.

Against Municipal Plant.

A special committee of the Common Council of Binghamton, N. Y., has reported adversely on the question of a municipal electric light plant. It is admitted among other things that the item of labor would cost the city 25 per cent. more than it does the present company. The price for lights to the city is $83.95, or $0.021 per lamp per hour, equal to or better than any municipal plant is doing on corresponding terms.

Telephone Transmitters.—IV.

By Arthur V. Abbott, C.E.

The Intensifying Transmitter.—This model is shown assembled, with the cover removed, in Fig. 24; in Fig. 25 the instrument is entirely dissected, excepting the capsule, while in Fig. 26 the parts of the capsule are shown. The foundation of the instrument is a heavy cast brass plate 3¼ in. over all. The diaphragm is of polished aluminum 2½ in. in diameter and .021 in. thick. The rubber strap

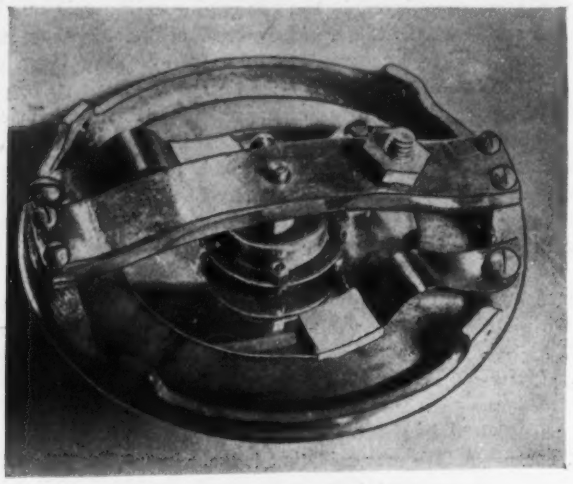


FIG. 24.—INTENSIFYING TRANSMITTER.

which forms a cushion for the diaphragm is 2½ in. long x ¾ in. wide. The bridge is a piece of wrought brass ½ x ⅛ in. thick and secured to the case by four screws. The springs are clock springs .01 in. thick, 5/16 in. wide and 2½ in. long, and bent at right angles. Each spring is tipped with rubber. One spring bears upon the rubber

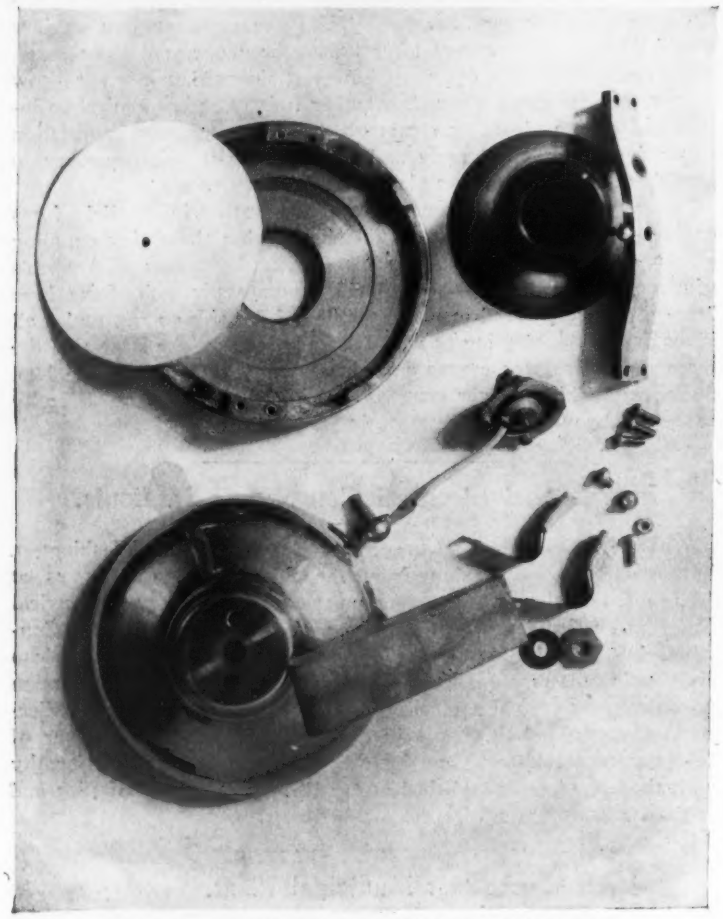


FIG. 25.—INTENSIFYING TRANSMITTER DISSECTED.

strap surrounding the diaphragm, while the other is placed half way between the diaphragm and the capsule. The capsule consists of a spun brass cup ⅜ in. in diameter inside, 3/16 in. deep and .015 in. thick. In the bottom of this capsule the rear electrode is placed, which is ⅝ in. in diameter and is soldered to a brass support that extends to the bridge. The front electrode is also of carbon ⅜ in. in diameter. Each electrode, including the brass supports, is .067 in. thick, giving a space of .07 of an in. between the faces of the electrodes. The front electrode is placed in the center of a mica disc ⅞ in. in diameter, .003 of an in. thick. This disc, as is shown in Fig. 24, is secured to the face of the cup by means of four screws

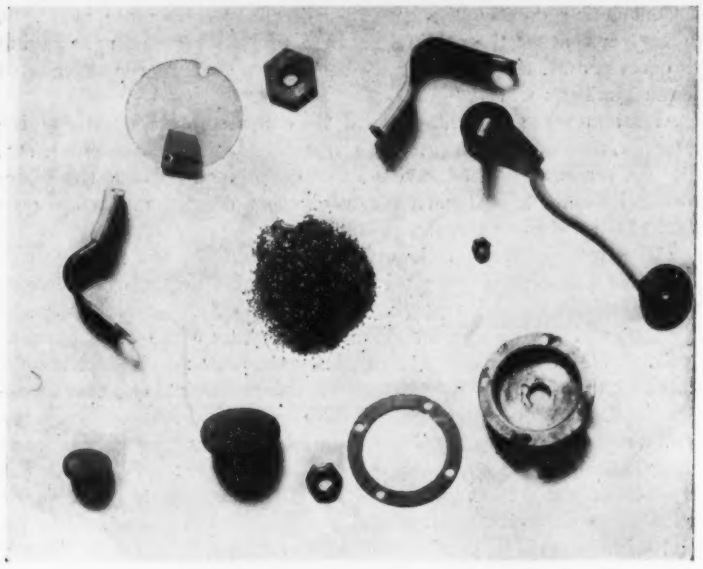


FIG. 26.—PARTS OF TRANSMITTER CAPSULE.

and a brass ring. The cup is filled with 8 grains of granular carbon. One electrode is connected to the case of the instrument, while the other runs to an insulating binding post upon the bridge and thence by means of a rubber-covered wire to the brass washer that clamps the mica diaphragm.

The Transmitter of the Western Electric Supply Company.—The rear cap of this model is shown removed in Fig. 27, while the instrument is dissected in Fig. 28. There is the usual cast face plate 3¼ in. in diameter over all. The diaphragm is rough aluminum 2½ in. in diameter by .023 in. in thickness. The bridge is 15/16 in. wide and ⅛ of an in. in thickness. It is surmounted in the center by a substantial block of hard rubber 5/16 in. thick, ¾ in. wide and 1⅜

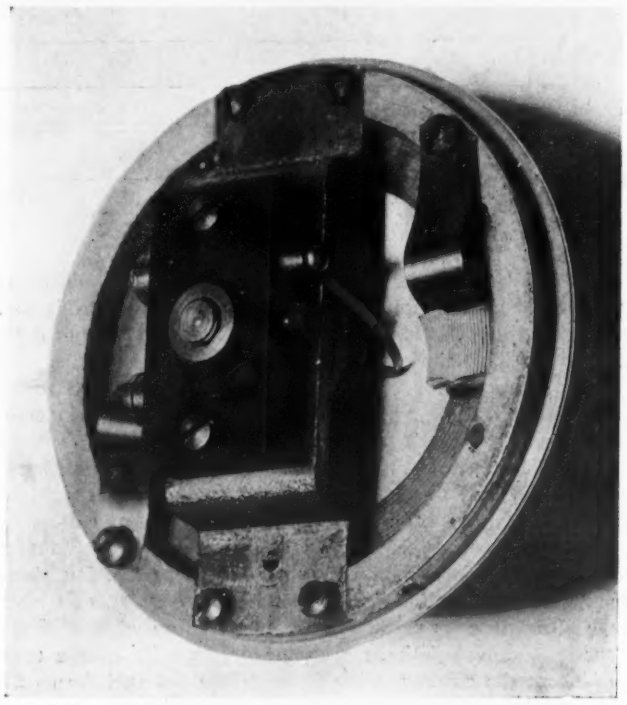


FIG. 27.—WESTERN ELECTRIC SUPPLY TRANSMITTER.

in. long. In the center of this block is a brass bushing which supports the capsule. The leading-in wires run to the rubber block and are thus connected respectively to the front and rear electrodes. The capsule consists of a brass ring 11/16 in. in diameter and ⅜ in. deep. Upon each side of this ring two mica washers are placed ⅞

FIG. 28.—WESTERN ELECTRIC SUPPLY CO. TRANSMITTER DISSECTED.

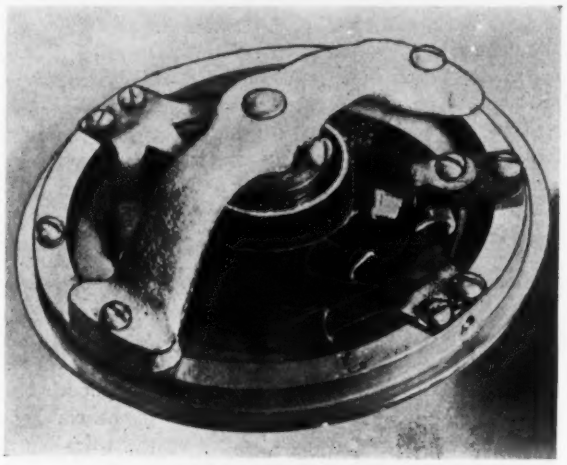


FIG. 29.—CENTURY TRANSMITTER.

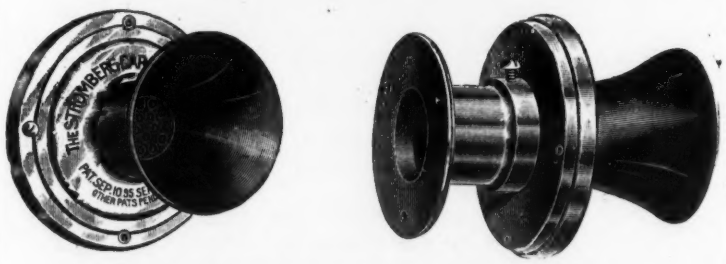


FIG. 31.—STROMBERG-CARLSON TRANSMITTER ASSEMBLED.

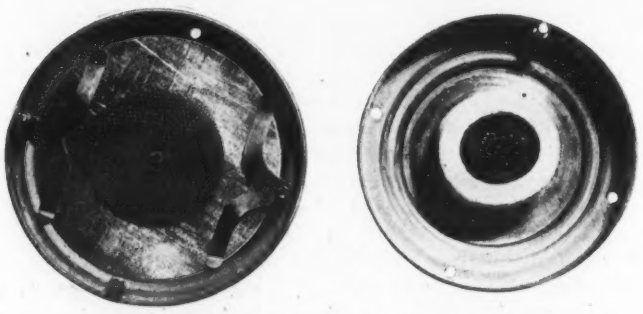


FIG. 32.—STROMBERG-CARLSON TRANSMITTER OPENED.

FIG. 30.—CENTURY TRANSMITTER DISSECTED.

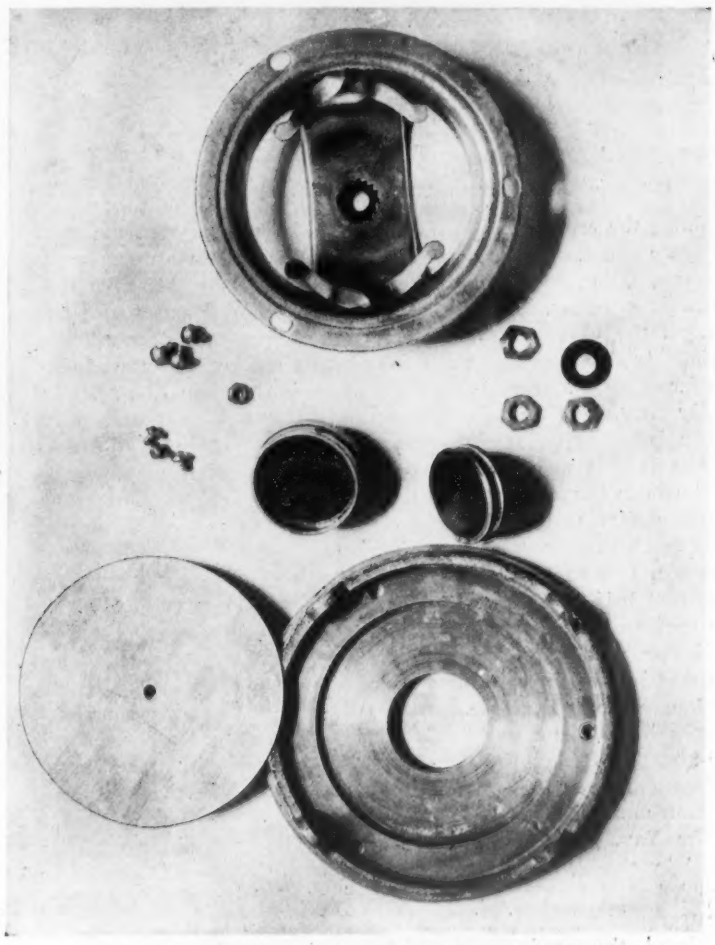


FIG. 33.—SWEDISH-AMERICAN TRANSMITTER DISSECTED.

in. in diameter and .005 of an in. thick. The electrodes of carbon are each ½ in. in diameter and clamped to its respective mica disc. The discs are then placed upon the ring and over each mica disc another brass ring is fitted and secured by means of four small ears, which are pinched underneath a ledge upon the center ring. Thus, in this model the front electrode can move to and fro with the diaphragm and also the entire capsule is movable through the elasticity of the mica washer that is supported on the rear electrode.

The Century Transmitter.—The transmitter manufactured by the Century Telephone Construction Company resembles in some respects that made by the Western Electric Supply Company. The Century transmitter, however, differs in having its diaphragm made of iron 2½ in. in diameter and .018 thick covered with varnish to prevent rusting. There are two carbon electrodes each ½ in. in diameter, the rear one screwed to a bridge made of cast brass. In Fig. 29 the Century transmitter with the rear cover removed is shown, while in Fig. 30 it is dissected entirely. The capsule is made of a piece of very thin rubber tube, about ⅞ of an in. in diameter and 5/32 in. long. It contains a piece of felt to which two mica discs are cemented. Each carbon electrode is supported by a disc of brass about ⅛ of an in. greater in diameter than the electrode, and after the capsule is filled with 10 grains of granulated carbon the mica washers are cemented to the felt ring, thus

FIG. 34.—SWEDISH-AMERICAN TRANSMITTER, CAP REMOVED.

retaining the capsule in position. In this instrument both the front electrode and the entire capsule can move with the vibration of the diaphragm, but here all comparison of the previously-mentioned transmitter ceases. To check undesirable vibrations of the diaphragm the Century transmitter provides two thin pronged iron springs, as shown in Fig. 30. Each of these is secured to the edge of the face plate by means by two screws, as is shown in Fig. 29.

The Stromberg-Carlson Transmitter.—The first of the so-called "Cornplaster" type transmitters, and one of the widest known models is that manufactured by the Stromberg-Carlson Company, as shown in elevation in Fig. 31, and opened in Fig. 32. This transmitter differs materially from general designs, so far illustrated. It is much smaller and lighter, for the case consists merely of two pieces of pressed brass. The diaphragm is of tin and is secured in the front half of the case by two springs, as shown in Fig. 32. In the center of the diaphragm a piece of wire gauze, which has been gold-plated, is placed, and serves as the front electrode. Upon the rear half of the case there is another piece of gold-plated gauze, forming the rear electrode. Between these two there is a round felt ring which is about two-thirds filled with granular carbon. When the ring is in place the two halves of the transmitter are put together and riveted, so that it is impossible to open the instrument without mutilating it.

The Swedish-American Transmitter.—The transmitter manufactured by the Swedish-American Telephone Company is shown assembled at *A* in Fig. 21. In the bottom of the casting, supporting the transmitter arm, the induction coil for local battery instruments is placed, the terminals of which may be seen in the illustration. Fig. 34 shows this transmitter with the rear cap removed, and in Fig. 33 it is dissected. The face plate is of cast brass, 3⅜ in. in diameter. The bridge is peculiar in that it is a substantial piece of sheet brass, formed in a die, as shown in Fig. 34, thus obtaining one of the stiffest and at the same time one of the lightest designs. There are two springs that are screwed to the bridge piece directly, each of which has two points; thus there are four points of spring contact on the diaphragm to check undesirable vibrations. The capsule is made of two pieces, one being a pressed brass cup, into which a grooved ring, carrying the front electrode, is placed and secured by four screws. The rear electrodes are ¾ of an in. in diameter and the front ⅜ of an in. and the cup is filled with 10 grains coarse granular carbon.

New Telephone Patents.

NOVEL JACK AND PLUG CONSTRUCTION.

Two patents have just been issued for rather novel constructions of jack designed to permit of greater facility of repair than common. In the making of connections both jack and plug are subjected to rubbing and consequent wear, and experience has shown that both must be in time replaced. This is an easy matter with plugs, which are always accessible. With jacks, however, it is an entirely different matter and therefore anything which can extend their life is of value.

Mr. C. M. Hedman, of Chicago, to whom the first of the patents under consideration has been issued, has applied to jacks a removable test ring. This threads into the hard rubber face strip of the jack strip, the end of the corresponding contact spring being expanded into a ring within the face strip drilling to form a stop for the test ring. Whenever a test ring wears out, of course, its replacement by a new one is but a matter of a few moments.

In the second patent, granted to Mr. W. W. Dean, of Chicago, the overcoming of the wear of the jack springs is chiefly considered, the wear being largely transferred to the plugs. This necessitates such a novel type of jack and plug that a clear understanding is best obtained by reference to a drawing of them (Fig. 1). As will be seen,

FIG. I.—DEAN TERMINAL AND PLUG.

the jack consists of two concentric tubes, one behind the other. The forward one, which engages the plug shank, has a smooth bore and flared front as is customary, while the rearward one carries an internal ridge about midway its length. The plug tip is flexibly mounted upon the end of a spring member, and stands normally somewhat off centre. When the plug is inserted, the ridge of the jack engages the plug tip to hold the plug in place. The result of this design is at once evident, for while ordinarily the wear of the jack spring is confined to a single element of its length while that of the plug is distributed over its whole periphery, now the plug wear comes upon a single element and the jack wear is distributed over its whole surface. The Stromberg-Carlson Company has obtained the first of these patents, while the latter has been assigned to the Kellogg Switchboard & Supply Company.

CONNECTION COUNTER.

A connection counter for use where measured service is the custom is the subject of a patent issued to F. R. McBerty, of Chicago. This counter is so designed and so connected to the circuits that it registers one message for each completed connection, and yet fails to register any other manipulation of the line. The counter is so designed and connected to the circuit that it is ready for operation at all times, except during a conversation. At this time it is locked. In other words, the counter responds only to the removal of the receiver from the hook at the answering station, and having once responded it so transfers its own connections as to lock itself against further scoring until after this connection has been taken down. Mr. McBerty has assigned his patent to the Western Electric Company.

BALANCING TRUNKS FOR DUPLEXING.

Of late considerable work has been done toward the use of duplex or phantom circuit working over trunk lines. The chief obstacle in the way of successful working in this way is the difficulty of securing and maintaining the necessary accurate balance of the trunk line to avoid interference. To overcome this difficulty Mr. H. O. Pugh, of Chicago, suggests the extension of the trunk line from the main

jacks to an adjustable rheostat, through the arm of which the second circuit, which is to use this trunk, is connected. The operator is supposed then to adjust the rheostat cutting resistance from one side of the top to the other until a condition of non-interference exists. The Illinois Electric Specialty Company has obtained the patent for this arrangement, which patent is confined to the simultaneous connection of two grounded and two metallic lines.

IMPROVEMENTS IN CABLES.

A new design of telephone cable has been patented by Francis Tremain, of England, in which the conductors are arranged in a special manner to permit of the use of two pairs to form conductors of lower resistance. The foundation conductors are ordinary twisted-pair insulated conductors; each has a uniform twist in itself, but there is a variation of pitch of twist in different conductors. Four pairs with different pitches are twisted together to form a strand. These four may, of course, be used to form two pairs, which pairs are inductively neutral to each other, and of which each conductor consists of a fundamental pair of conductors. Thus, for long circuits conductors may be used of half the normal resistance. It is, however, difficult to see what advantage such an arrangement has over two twisted pairs taken in parallel, wire and wire, in which latter case irregularity of resistance due to difference in pitch of twist is avoided. Another patent referring to cable construction is that of H. W. Fisher, of Pittsburg. This relates to a method of wrapping paper insulation about the wires for telephone cables by which the paper strip is caused to crimp. The result is a bulky insulated conductor, a larger part of the volume of which is air-space. Such conductors twisted loosely together form a cable with low electrostatic capacity because of the large proportion of air insulation. This patent has been assigned to the Standard Underground Cable Company, of Pittsburg.

TWO NEW LINE PROTECTORS.

A rather novel open-space lightning protector is that of Charles E. Nicholas, of Columbus, Ohio. This consists of a metallic tube surrounding the conductor to be protected and held concentric therewith by insulated bushings. High-potential charges pass to the tube and are thence conducted to ground. An interesting suggestion is the use of such a device let into the cross-arm and serving as both protector and insulator. Another line protector is that of W. P. Woodruff, of Buffalo, and Daniel J. McCarthy, of Wilkinsburg, Pa. These inventors provide a magazine fuse terminal in which a large number of fuses may be stored. As fast as one operates, the melting fuse permits the spring terminals of the device to release the fuse carrier, when a fresh fuse is immediately provided from the magazine. The utility of such a device is questionable. With a considerable capacity to the magazine and a bad heavy current cross it would seem that all the fuses will be quickly blown, even if it can under any circumstances be considered good practice to continually re-fuse a line in trouble without ascertaining that trouble.

BATTERY TRANSMITTER.

Under the above title John S. Golberg, of Chicago, has patented the transmitter shown in section in Fig. 2. The most novel feature

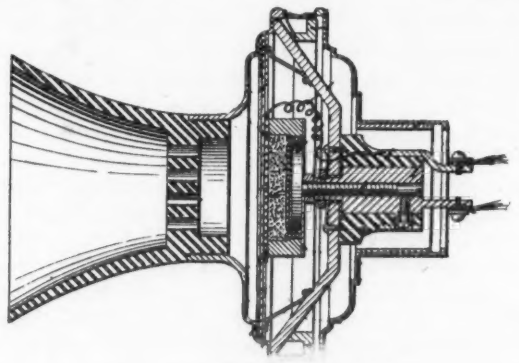


FIG. 2.—GOLDBERG TRANSMITTER.

consists of two spring spiders, one to hold the diaphragm and the second to give an added flexibility to the carbon chamber. The diaphragm spider is shown in section and appears as a truncated cone. This cone shape makes it virtually self-centering. Arising from each leg is a sheet spring finger which engages the diaphragm. The second spider, also of sheet spring metal, is clamped to the rear electrode in a manner such that the ends of the legs bear upon the rim of the granule box. The packing about the rear electrode is felt, which is alone less satisfactory in permitting free motion of the electrodes than when supplemented by the spring spider. The Stromberg-Carlson Company is the assignee of this transmitter.

AUTOMATIC EXCHANGE.

A patent has been recently granted to F. A. Sundquist, of Chicago, for an automatic telephone exchange which is in the nature of an improvement on a system previously patented by him. The switchboard is designed for large systems involving auxiliary switching processes. All parts seem to be well worked out, and the circuits and apparatus comparatively simple. This system has the merit that the work required of subscribers is of a simple nature, and it seems to compare well with existing apparently successful systems.

TELEPHONE WALL SET.

A new arrangement of apparatus box for telephone wall sets is the subject of a patent issued to E. B. Fahnestock, of New York. The novelty lies in an arrangement of the hinge of the swinging front such as to permit of the condenser of the set being slipped out of the box between the cover and the back board through the hinge opening.

The Design of Motor Starting Rheostats.

By Arthur H. Ford, E.E.

THE writer has frequently had trouble with motor-starters due to the rush of current, when the final resistance was cut out, being so great as to throw the circuit-breaker or blow the fuse used to protect the motor. An investigation has shown that this is a defect of nearly all motor-starters. Under the usual conditions, when the motor is started light, this is not noticed; but if the motor is required to start a load requiring nearly its full load torque, the shock to the belting and motor is serious, to say nothing of the annoyance of being obliged to set the circuit-breaker or replace the fuse frequently. In many cases the person who starts the motor makes a practice of holding the breaker in, if it is within reach, or tying it fast if it is not. These facts led to an investigation of the problem which resulted in the general solution given below.

The solution is given for a shunt motor on a constant-pressure circuit of unlimited capacity; but is equally applicable to a series or compound motor, provided that the motor resistance is high in comparison with the resistance of the generator and line. When power is first turned on there is a rush of current through the machine determined by the pressure of the circuit and the combined resistance of the rheostat, armature and connections. The armature now begins to revolve at an increasing speed, having for its limit that speed at which the counter e.m.f. required to keep the current down to the value which gives the necessary torque, is generated. If, when this state is reached, one section of the rheostat is cut out, there will be a sudden increase in the current, which will have the same value as if an e.m.f., equal to the fall of potential over the section cut-out, had been introduced into the circuit and its resistance reduced by an amount equal to that of the section cut out. This cycle of action is repeated each time that a section of the rheostat is cut out. In order to get the motor up to speed as soon as possible, the sudden rush of current should be the same for each section of the rheostat cut out and should be as large as safety will permit. This will give a current through the armature which will vary from a maximum to a minimum, successive values of which will be the same, provided the torque is constant or a section is cut out of the rheostat each time the current falls to a given value.

Let n = the number of divisions of the rheostat.
R_a = the resistance of the armature and connections.
R_m = the resistance of any rheostat section.
I = the minimum current through the armature during the starting period.
$I(1+a)$ = the maximum current through the armature during the starting period.
E = the line pressure.

Under the conditions just stated,

$$Ia = \frac{I R_n}{R_a + R_1 + R_2 + R_3 + R_4 \ldots + R_{(n-1)}} =$$

$$\frac{I\,R_{(n-1)}}{Ra + R_1 + R_2 + R_3 + \ldots + R_{(n-2)}} =$$

$$\frac{I\,R_2}{Ra + R_1} = \frac{I\,R_1}{Ra}.$$

from which $R_1 = a\,Ra$

$R_2 = a\,(Ra + R_1)$

$R_n = a\,(Ra + R_1 + R_2 \ldots + R_{(n-1)})$,

giving as the general expression for the resistance of any rheostat section,

$$R_m = a\,Ra\,(1 + a)^{m-1} \qquad (a)$$

When current is first turned on,

$E = I\,(1 + a)\,(Ra + R_1 + R_2 + R_3 + \ldots + R_{n-1} + R_n)$

from which $E = I\,Ra\,(1 + a)^{n+1}$ (b)

Equations (a) and (b) enable one to calculate the number of steps and the resistance of each, provided that the starting conditions, resistance of armature and connections, and line pressure are known.

An application of this method to various machines (assuming *Ra* to be twice the armature resistance, *I* the full-load current, and *a* to be .5) shows that starting rheostats should have about nine sections.

The Adoption of Direct Current Traction on the New York Central Railroad System.

Considerable space has recently been given in these pages to the eventful and historical determination of the New York Central Railroad to adopt electricity for the operation of virtually the whole of its train service at the New York terminal and within a circle whose radii extend at least 35 miles out from the Grand Central Depot. This decision by one of the oldest and greatest of the steam railroad systems in the United States has naturally attracted attention everywhere and aroused the most profound interest. The action of the New York Central Railroad Company in adopting the report in favor of electricity from its commission organized under Vice-President Wilgus to investigate the subject, is one fraught with such momentous consequences alike to the public and to the engineering profession and industries that even the slightest light which can be thrown upon it is of value. In fact, it would be difficult to overestimate the importance of the event, which easily takes its place as the most significant in the history of electrical engineering in 1903.

The readers of ELECTRICAL WORLD AND ENGINEER will remember that the contracts given out by the New York Central Railroad Company embodied two startling innovations and one not less interesting evidence of conservatism. In the first place it has been decided to operate the generating plant by steam turbines, and in the second place it has been decided to operate a very large part of the traffic, namely, that embracing all through trains, with electric locomotives of not less than 2,250 hp each. Striking as the boldness is in these two developments, it is considered by some engineers as offset by remarkable prudence amounting even to conservative timidity in adhering to the direct-current method instead of pushing boldly forward and adopting at once alternating-current apparatus. Under the circumstances we have deemed it desirable to ascertain if possible what the reasons may have been for adopting the direct current in the New York City zone. Neither the railroad company nor its commission has hitherto been willing to give out any official statement upon this interesting subject, but we believe we are justified in submitting below a brief summary of what may be accepted authoritatively as the considerations which led directly to their action. The result of our inquiries on the subject is such as to throw a flood of interesting light upon a great many new points, although it is possible that in some respects we do not fully appreciate or adequately present the force of all the arguments which have compelled resort to direct current at the present time.

The reasons for the action of this great corporation, it would appear, may be divided into two classes, namely, those of policy and those of engineering technique. The word policy in this respect is one of large meaning, but the idea is that the system adopted should leave the widest latitude for the possible future interchange of equipment with other analogous local systems. The New York Central Railroad in determining to minimize as much as possible the inconveniences to the public in this work, has at once realized that as other rapid transit lines in this city are and will be equipped with direct-current motors, its work must be in harmony with theirs. The adoption of the direct-current system, therefore, while leaving optional the selection of the best method of the future handling of the transportation service would facilitate rather than hinder changes which would have now to follow the change in operation and in financial conditions. On the other hand, the employment of the alternating-current system, individual and unique so far as the New York Central road is concerned and not corresponding with the local systems into which it must inevitably interweave itself, would prevent such harmonious action. At a time of extraordinary transition in all the transportation arrangements of New York City, it would have been in all probability a serious and an irreparable error for the New York Central Railroad to have adopted that which is not only newest in the art, but unrelated to that which is already standard and in use in and around New York City. We have ourselves no knowledge or intimation as to the plans and ambitions of the New York Central officials as to the local systems, but such reasons of policy as we have hinted at can certainly be postulated as amongst the prior considerations on the subject governing their action.

With regard to the technical reasons, we have, as our readers are well aware, presented recently in these columns, a vast amount of matter with regard to the advantages of the alternating-current method of traction, and have set forth in great detail the single-phase work of such leaders in this field as Arnold, Lamme, Finzi, Winter-Eichberg, Ward Leonard and others. In view of so much work of promise for the future and of such an elaborate presentation of the alternating-current arguments, we have been particularly anxious to ascertain the technical reasons why the direct-current system appears to the experts and the commission entrusted with the subject to have determining advantages over the alternating-current system at the present stage of development. We hardly know whether the matter of cost should be considered a technical one or not. At this stage of development between the two systems it has undoubtedly been one with serious effect on the matter. The board under Mr. Wilgus, it would appear, found that there was a great uncertainty as to the relative costs of the installation of direct current and of alternating-current apparatus, due obviously to the recent rapid development in the art as applied to alternating-current motors. Hence, while one of the bidders had apparently no trouble in showing a considerable difference of cost in favor of direct-current apparatus, another bidder, at the very latest stages of the settlement, brought to notice a type of alternating-current motor, which it was claimed would cost but little more than the direct-current apparatus. Further than this, it would appear to have been claimed that the overhead construction with alternating-current devices could be avoided on the Park Avenue viaduct and tunnel, and this, if true, would remove one of the strongest arguments against the use of the alternating current.

On the other hand, if we assume that a high-potential third rail could not be avoided, but that overhead construction would be necessary on the viaduct and tunnel, and taking into account the differences in the bids, there would seem to be a large difference in cost in favor of the direct-current system. If the figures were available and were before us, we could possibly make a more specific exhibit of the difference in cost referred to. The situation is, therefore, not a little complicated by the pros and cons in respect to cost, but it would seem that the very points thus alluded to have played their part in bringing about the decision in favor of the direct current. It can readily be understood that a great many features of objection in the minds of the railroad company would attend the use of the overhead construction of bare wire with the alternating-current system, including the liability of injury to trainmen as well as the tendency to corrosion of wires from the gases of freight steam locomotives. There are also obvious dangers and difficulties in lowering the four tracks of the Park Avenue tunnel under the existing enormous traffic, and a great many legal uncertainties crop up in connection with the construction of an overhead system on the Park Avenue viaduct. Admitting that the overhead construction could be avoided on the viaduct and in the tunnel, the difference in cost, if we understand the facts aright, would undoubtedly have been in

favor of the alternating-current apparatus, but viewed broadly and all things considered, the arguments for the direct-current system have prevailed, being supplemented by others of equal moment to which we shall now refer.

Amongst the points which we have elicited is one to the effect that the alternating-current locomotive would have a greater weight, thus adding from 7 to 10 per cent. to the train weight, with a consequent increased cost of transmission, installation and operation of the power plants, which would more than offset the economy due to the use of static transformers instead of rotary converters. Further than this, the alternating-current apparatus for both motor cars and locomotives would involve greater cost of maintenance.

The next point would appear to involve the greater depreciation in value of the alternating-current type of apparatus, and due to the curious fact that being now novel and more or less untried it would inevitably soon have to be discarded and scrapped to make room for improved types in the near future, whereas direct-current apparatus being standardized and universal in application, would prove a good asset with a high percentage of salvage whenever a change to alternating current might prove itself to be necessary. Over and above these leading considerations, others involved are the present imperfect development of alternating-current apparatus when viewed in regard to the complex and important traffic on the New York Central Railroad, which must be handled safely and successfully without any ifs or buts, the paralysis or temporary interruption of such a great national highway being attended with losses to the company and to the public beyond calculation. It is to be remembered, moreover, that the company is required to make a local change within a very short given period of time and without any chance of failure; and this being the case the conviction has been irresistible that direct-current apparatus is at once the safest and the only type to adopt to meet the stringent conditions imposed by the legal, financial, engineering and other broad considerations bearing upon the question.

It is not to be understood for a moment that the alternating aspects of the subject were not fully weighed, and from all we can learn in regard to this matter they were given the most prayerful consideration up to the very latest moment, but even allowing that the alternating-current system under the most favorable circumstances might cost a great deal less than the direct-current system, there remained the other reasons of policy and engineering technique which, so far as the commission and the railroad company were concerned, removed the last shadow of doubt as to the wisdom of adopting direct current within the proposed electrical zone, south of Croton and North White Plains. Going beyond this important and initial zone there would appear to be later on abundant opportunity for resort to the alternating current when its perfection would warrant its adoption for long-distance service. How close at hand this is no one can say. A great deal of the best invention and work of the time points in that direction, but meanwhile it must be felt that the New York Central Railroad Company is to be commended for the high prudence and wisdom which has been associated with its adoption of the most progressive policy seen in the main railroad field for a great many years. In fact, one might well call it the most momentous decision of the kind of the last half century.

Recent Electrochemical Developments.

MANUFACTURING MANURE FROM APATITE.

A patent issued to Mr. Wilhelm Palmaer, of Stockholm, Sweden, relates to a method for making bicalcic phosphate from apatite. In the bicalcic phosphate the phosphoric acid has the same manurial value as the phosphoric acid of superphosphate soluble in water or citrate solution. The process consists of several steps. The first step is the electrolysis of a solution of a suitable salt (chlorate of sodium or periphlorate of sodium), which yields at the anode an acid forming with lime a soluble salt and at the cathode a basic hydrate. The acid obtained at the anode is made to act on mineral phosphate in a separate vessel. To the acid solution of the mineral phosphate thus obtained the alkaline solution formed at the cathode is then added and precipitation of bicalcic phosphate results.

CURRENT NEWS AND NOTES.

WORK WITH RADIUM.—Prof. Roux, of the Pasteur Institute, reported last week some interesting experiments Dr. Danis made with radium. He hung a tube containing the metal above a cage containing mice for fifteen hours. Twenty days afterward the rodents began to lose their fur, which grew again, but of a different color, gray mice becoming white. When the period of exposure was extended the animals succumbed to paralysis, the younger mice being the most quickly affected.

CHICAGO MEETING A. I. E. E.—The coming meeting to be held January 12 is to be one of special interest to central station men, as an opportunity will be afforded for a free discussion of the papers presented at the New York meeting December 18. These will be abstracted briefly and Mr. Lamar Lyndon's paper presented at the previous meeting read at the same time. The committee has received assurance of the attendance of a number of central station men from out of the city.

NEW MULTIPLE VOLTAGE DISTRIBUTION SYSTEM.—A patent has been issued to Mr. George H. Gibson on a multiple voltage generator which allows a large number of voltages to be taken from a single machine. The generator has a double armature winding and the Dobrowolki principle is utilized of producing on a point of the winding of an external inductance an image of the neutral point of an armature winding, to which point a supply neutral conductor is connected. The machine has two commutators—one for each armature winding—and two sets of slip-rings for the neutral connection. The neutral or fifth wire of the distribution circuit is, by means of a special disposition described, made to act as a neutral for both commutator circuits. Assuming that the voltage at one commutator is 50, and at the other 200, voltages of 25, 50, 75, 125 and 200 are available on the distribution circuit.

ANNUAL DINNER OF THE BRITISH INSTITUTION OF ELECTRICAL ENGINEERS.—The British Institution of Electrical Engineers held its fifteenth annual dinner at the Hotel Cecil December 9, with a large number of distinguished guests present. Among these were Prof. E. Hospitalier, president of the Société Internationale des Electriciens; Sir W. H. White, Sir W. Ramsey, Lord Reay, Lord Monkswell (chairman of the London County Council), Lord Biddulph, Lord Claud Hamilton (chairman of the Great Eastern Railway), Hon. A. Brodrick, Sir Norman Lockyer, Prof. S. P. Thompson, Lieut.-Col. Crompton, Sir A. R. Binnie, Prof. W. E. Ayrton, Sir J. Wolfe Barry, Sir W. de W. Abney, Sir G. L. Molesworth, Sir J. F. Bridge, Major-Gen. W. T. Shone, Major-Gen. C. E. Webber, Sir H. Mance, Lieut.-Col. H. A. Yorke, Col. R. M. Ruck, Col. W. Pitt, Mr. R. B. Martin, M.P., Sir C. J. Owens and Mr. James Swinburne. About 500 were seated and one of the English journals ascribes the great success of the occasion to a new feature of the programme, which provided, after the formal ceremonies, a period of informal social intercourse. Lord Monkswell spoke on "The Institution of Electrical Engineers" and Mr. J. Swinburne, Sir C. J. Owens and Sir J. Wolfe Barry on "Railways and Telegraphs." Prof. S. P. Thompson proposed the toast, "Our Guests," compiling with it the names of Prof. Hospitalier, Lord Claud Hamilton and Sir William White. Prof. Hospitalier, on rising, received an enthusiastic welcome which, according to one of the accounts, "was well-nigh endless." He referred with pride to the fact that for 22 years he had been a member of the Institution. Sir William White, in replying, said he did not believe in a hard and fast separation between scientific societies and engineering societies. There was a distinction between pure and applied science, but a man who devoted himself to the application of science was equally as worthy of respect as the pure science man; and in connection with education matters engineers must not permit pure scientists to say what should be the training of the engineer. Sir William White, it may be added, is one of the "old guard" committed against the modern methods of technical education. After the dinner the company adjourned to a hall where members had an opportunity to meet the distinguished guests.

POWER STATION AT CAFFARO.—The numerous water powers found in the Italian Alps are now being used very extensively for developing electric power. One of the largest lighting and power plants is now being built in the Province of Brescia, on the Italio-Austrian boundary, at Caffaro. The station will be equipped with five generator units of 2,500 hp each, all furnished by the Oerlikon Company. The main line to Brescia will be 50 km. long and will carry 40,000 volts. Aside from the Bülach-Oerlikon transmission line, this is probably the only one in Europe transmitting so high a voltage. In connection with this power station, there will be a transformer sub-station of 3,250-hp capacity for operating an electro-chemical factory.

INSTRUMENT DIAL PLATE.—A prolific cause of trouble in indicating electrical instruments is the tendency of the scale to warp and hold the the pointer. To obviate this annoyance Mr. J. Franklin Stevens has devised and patented a method of constructing scales or dial plates which, though simple in detail, is stated to maintain a plate in perfect condition indefinitely, and to completely overcome all tendency of the cardboard to separate from its backing or to warp or blister when subjected to moisture. The method, briefly, consists in perforating the metal plate to which a scale card is secured, thus enabling the cement employed to sink in the perforations and thereby effect a closer union and contact with the metal The plate may be, say, 20 to 25 mils. in thickness, having about 400 perforations per square inch, each about 25 mils. in diameter. A slow-drying cement is used, and a moderate amount of heat is employed while the card and metal backing are subjected to pressure. After all scale divisions are on the card the face is coated with pure white lacquer or similar colorless water-proof substance.

LETTERS TO THE EDITORS.

Motor Drive in Railroad Shops.

To the Editors of Electrical World and Engineer:

Sirs:—I have read with great interest Mr. R. Lozier's very able article in reply to my own, on the subject of machine tool drive, yet I must still adhere to the ideas advanced by me as far as railroad shops, or, in fact, any large shops are concerned, but agree with Mr. Lozier this far that if the shop is small, and the output varied, such an equipment as he describes may justify the increased cost of the multi-voltage system.

In a railroad shop, or in any large shop where there are a large number of tools installed, if the shops are properly laid out, the work will be adapted to the tool, namely, a tool that will do a certain class of work year in and year out. As an illustration, in a railroad shop, an axle lathe will turn axles, a wheel lathe will turn wheels, and so on, and the wheel lathe should not be called upon to do small work. Therefore, the speed at which these machines will run should never vary to any large degree. The maximum speed possible is quickly and easily obtained by the method outlined in my previous article, and a motor ordered for that rate of speed. Now, if there chance to be a few rare cases in which the speed must be varied, the cone pulleys can take care of the change readily, and far more economically than the multi-voltage system, of which the interest on the large initial outlay, goes on year after year, in addition to depreciation. And that the multi-voltage system is costly, no one who has figured on installing it can deny.

Mr. Lozier cites as an instance the finishing up of an armature spider, where the motor is speeded up and slowed down at short intervals. This is very well, but railroad shops do not do this class of work. Still, in a large shop, where this work is done, I see no reason why the work could not be arranged so that each tool could do certain work, and then the spider be passed on to the next tool, if there were many of them to do.

Again, in taking up my ideas on the grouping of tools, with a single motor to a group, at constant speed, Mr. Lozier admits the advantage of a motor without a commutator, but weighs against this the possible factor of wattless current.

Now the factor of wattless current only becomes apparent when the induction motor is underloaded, and it then becomes a mere question of judgment in determining the load factor of your group, and selecting a motor that will be so small as to have an efficient load. If a larger load does happen to come on at rare intervals, it is a well-known fact that the induction motor can take care of overloads with far greater ease than a direct-current motor, can, in fact, be blocked at full current without injury, which cannot be done in the case of the direct current, so this objection then becomes nil.

He also fails to state another factor in the case of the multi-voltage system, namely, the controller required. Now, as regards controllers, reversing the statement of the Irishman about whiskey, "some controllers are better than others, but there are none good," and when you throw this question into the balance, the advantage is altogether in favor of the induction motor, as any one who has had to maintain a large controller equipment can testify.

Again he speaks about the certain amount of direct current necessary for cranes in any case. I may say here, that on future installations projected by me that alternating current will be used throughout, for cranes as well as tools, as the alternating current crane has passed the experimental stage, and become a commercial success, and is as easily operated as a direct-current crane.

One word more and I have finished. Mr. Lozier and others have laid great stress on the fact of the operator being able in the multi-voltage system, to vary the speed of his work at will. Here I must differ from him radically, as I do not think that the operator should be allowed to vary from the instructions given him by his shop superintendent. Were this permitted every man would need to be of such high class and skill, that the cost of production would far outrun the economy gained, or else the amount of work and tools ruined would produce the same result.

In summing up, therefore, I may say that while Mr. Lozier's views are sound and well taken from his point of view I must still adhere to my own, as regards economy of installation, and operation, and I may here quote the saying of a high authority regarding an engineer. He says, "A successful engineer is the one who can make a dollar earn the most money." This saying is most true where large corporations are concerned, and doubly so in the case of small ones.

Montreal, Can. C. H. Hines.

What is Not New in Peat Treatment.

To the Editors of Electrical World and Engineer:

Sirs:—On page 1014 of your December 19 issue I note your remarks in describing the would-be new telephonograph alleged to be just invented in England: "This was all done successfully years ago—let us have something really new." It is a pity you did not put the paragraph relative to the electrical preparation in England of peat, on page 1010, in the same category. The process described therein is identical in all essential respects with that described in the patents of Charon and Oligny issued something like two years ago in the United States. As I had a good deal to do with these patents and the experiments carried on under them at St. Isidore, Quebec, I am thoroughly familiar with the possibilities in this line, and it may as well be stated that, as regards electrical treatment of peat to carbonize it, there is absolutely "nothing in it." In fact, a very easy calculation will show that the mere cost of evaporating the water remaining in peat even after it is dried as thoroughly as possible by presses or centrifugal dryers costs more per ton than the price of coal. It is all very beautiful in theory to "expel all but a small remnant of the 80 per cent. of water" by a centrifugal machine, but anybody who is any way familiar with this class of machine knows that it can't be done. As for "moistening the mass with certain cheap chemicals," this is reminiscent of the "secret liquid" forming so prominent a feature of promoters' schemes, and it is practically safe to say that whether the liquid be cheap or otherwise does not change the character of the proposition.

It must be obvious to every one that the evaporation of water by electrical heat necessarily costs at least ten times as much as by direct heat from the fuel, for the simple reason that only one-tenth, at the maximum, of the heat of the coal is represented in the electric current produced therefrom. Hence it is perfectly obvious that the electrical process cannot compete with the direct process.

As for the alleged superiority of the electrical current in that "it converts but does not destroy any of the valuable elements of the peat, whereas coking by fire heat expels a large percentage of these elements in the form of gases, which being either wasted or burnt as fuel beneath retorts are lost from the composition of the ultimate

product"—this is mere "springes to catch woodcocks." When peat is coked by direct heat in suitable retorts the gases expelled are principally water and incombustible gases, and they are utilized as far as possible to coke the peat by burning them (that is, the combustible portion) under the retorts, and are in nowise wasted. As for being valuable elements of the composition, that is nonsense.

Your citation gives the "high thermal value of 9,000 British units" as the result obtained by this alleged new process. As a matter of fact I consider this a very low thermal value, scarcely exceeding that of good hardwood. Ordinary lignite has shown as much. The Canadian briquetted peat already produced, as above alluded to, which I have seen burnt, has given a value of 12,437 B. T. U., as shown by tests of the Quebec Government Assay Laboratory, and but 2.87 per cent. of ash. The cost of producing such peat, not by the electrical, but by other processes tested, was estimated at between $1.50 to $2, and it is perfectly safe to say that this is the very lowest which can be reckoned on anywhere. The cost of producing it in the manner mentioned in your article would actually be found between $6 and $10 per ton instead of $1.21 as given.

MILWAUKEE, WIS. GEORGE W. COLLES.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternator with Direct Excitation by Alternating Current.—HEYLAND.—A very long paper illustrated by diagrams, read before the Electrical Society, of Berlin. He describes in detail the principle of his new system of self-excitation and compounding of alternators which has already been noticed several times in the Digest. The first experiments with this type of alternator were made by Kolben & Co., and this firm has already placed a considerable number of machines of this type on the market. The machine is of the construction of an ordinary alternator with stationary armature and revolving field. The essential difference from the ordinary machine is that the exciting current is not supplied from an exciter, but the alternating current generated by the machine itself is, with the aid of a commutator, supplied to a peculiar system of parallel windings around the poles. The principle of the machine is discussed and diagrams are given which represent its behavior. The claims which he makes for this alternator are as follows: Compared with the ordinary alternator his new machine is distinguished by a better utilization of material (less weight of copper and iron per unit of power), by higher efficiency and by a more exact regulation. Since the armature reaction is removed, dimensions may be chosen for the machine which one would obtain with ordinary alternators with high armature reaction. With an ordinary alternator the maximum permitted voltage drop is generally given, and from this result the necessary field strength and the dimensions of the poles and iron cross-sections follow. His type of alternator may be built with a relatively weak field, so that all the dimensions are at once reduced, together with the iron losses, the copper losses and the copper on the poles. The machines have a high efficiency and the efficiency curve is good for all loads, since it increases rapidly for small loads and then remains nearly constant over a wide range of load. Another advantage is the absence of a direct-current exciter. If no exact compounding is required, but only regulation of voltage within the usual limits, the compounding transformer may be omitted altogether and the machine becomes very simple, requiring in operation in parallel no balancing wires or other accessories. The advantage due to the absence of the armature reaction is greatest in machines with few poles and running at a high speed, or in machines for low frequencies. After the paper had been read there was an extended discussion, a full report of which is given. It was brought out there that Heyland uses two transformers, one for compounding and the other for exciting.—*Elek. Zeit.*, December 17.

REFERENCE.

Commutator.—MASON.—A communication giving instructions for amateurs how to make a commutator.—*Am. Mach.*, December 31.

LIGHTS AND LIGHTING.

Photometric Tests of Nernst Lamps.—SHEPPARD.—A communication referring to the fact that the candle-power of a Nernst lamp of American make varies very considerably with a small difference in voltage; thus a 1 per cent. variation makes a change of 6.4 per cent. in the candle-power. He considers this to be a characteristic difference with respect to Nernst lamps of German make. The data for the latter are given in Fig. 1, in which the full-line curve refers to the Nernst lamp of German make, while the dotted curve referring to the carbon incandescent lamp is given for comparison. An increase of voltage from 100 to 105 causes an increase of the candle-power by 1.5 per cent., and a drop of the voltage from 100 to 95 reduces the candle-power by 30 per cent. In England Nernst

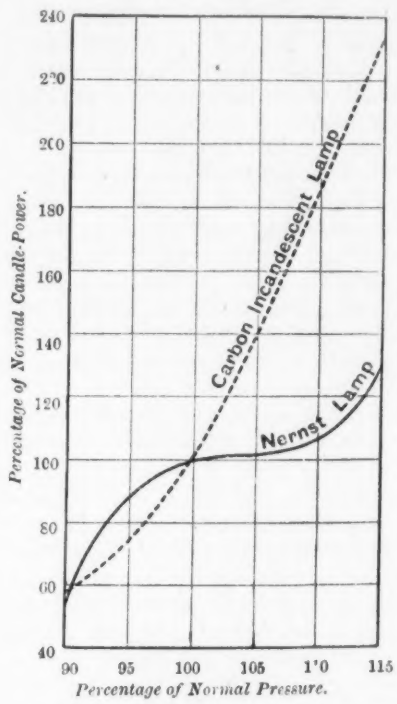


FIG. 1.—CURVES OF PHOTOMETRIC TESTS.

lamps are required to be suitable not merely for the nominal pressure of the supply, but also for the maximum pressure likely to be met with. With the curves he considers that this is sound economy.—Lond. *Elec.*, December 18.

POWER.

REFERENCES.

California and Niagara Power Transmission.—DUNLAP.—A comparison. In California widely separated electric systems have been unified into a single and very extended unit of large proportions and great mechanical difficulties had to be overcome. Niagara Falls power is in the midst of a thickly-settled section.—*Wesgt. Elec.*, December 19.

Superheated Steam.—REYNOLDS.—An abstract of a paper read before the Rugby Engineering Society in which the author explains the principal objects of the use of superheated steam and the precautions which must be taken.—Lond. *Elec.*, December 18.

Indicator Diagrams.—HUBBARD.—An illustrated article in which the author explains the indicator cards with reference to the internal working of the engine from which they are taken. The author gives cards showing the most common faults in the distribution of steam in the cylinder, such as too early or too late admission, too early or too late cut-off, too early or too late release and too early or too

late compression. Directions for remedying all of these faults are given.—*Am. Elec.*, December.

Condensed Steam.—PARKINSON.—An article on the utilization of condensed steam in central station economies. A simple filter for removing oil from the condensed steam, to render it suitable for boiler feeding, is described and illustrated.—Lond. *Elec. Rev.*, December 18.

TRACTION.

Alternating-Current Traction.—EBORALL.—The first part of an illustrated paper read before the Manchester Section of the (British) Institute of Electrical Engineers. For urban and interurban tramways three-phase working is out of the question, and even if the single-phase motor should ultimately become an important factor in electric railway work, for this kind of roads. With regard to working costs, a certain economy would naturally result from the substitution of transformers for rotating converting machinery in substations, but this saving would not appreciably influence the total costs of operation, on account of the increased energy consumption in the secondary network. It is hardly likely that the all-round performance of any type of alternating-current equipment will ever equal that of the corresponding direct-current equipment, at any rate under the conditions usually prevalent in urban and interurban tramway work. However perfect the phase compensation of such motors may become, the losses in them and in the distributing system must be greater, other conditions being equal, while on the other hand the maintenance charges are not likely to be less. For overhead, underground and suburban electric railways, the situation seems a little more favorable to alternating-current working; but the commercial success of such lines turns very largely upon the question of rapid acceleration obtained at minimum cost with the help of a simple and flexible arrangement, and in this respect the direct-current equipment is superior to the alternating-current equipment, no matter what arrangements are made with regard to the starting and speed control of the motors. For branch lines and light railways and for high-speed railways where the distances are considerable and acceleration periods are relatively insignificant, the case is quite different. For such work the disadvantages of three-phase working are by no means serious. The author then discusses the principal features of three-phase motors and gives in a table a comparison between typical standard high-speed 500-volt railway motors of the three-phase and direct-current types, the former being arranged for 25 cycles. There is no great difference between the weight and dimensions of the two types of motor, what difference there is being in favor of the direct-current motor. The cost of the three-phase equipment is considerable in excess of that for direct current. Considered from the general engineering standpoint and from the point of view of cost of up-keep, the three-phase motor has the advantage. The speed control of the three-phase motor on tramways must be either a rheostatic or tandem-parallel control. With control by means of rotor resistances, a starting torque per motor equal to nearly three times the normal full-load torque is available for acceleration if necessary, provided the normal pressure is maintained at the motors; but it is accompanied by large losses in the rotor resistances. Still larger torques can be obtained for quicker acceleration if desired by increasing the pressure on the motors; but the result is even greater total losses. Generally speaking, the power consumption of well-designed three-phase motors during the starting period, when employing rotor resistance control, is of the order of 20 per cent. more than that required by the corresponding direct-current motors, starting under the same conditions, with the help of series-parallel control. This is the case for moderate accelerations, while for very rapid accelerations the difference in favor of the direct-current equipment is still more marked. The paper is to be concluded.—Lond. *Elec.*, December 18.

Single-Phase Traction with Speed Regulation.—LATOUR.—An article in which he says that the following three types of commutator motors may be considered as suitable for single-phase traction, all three allowing perfect operation near synchronism: First, the repulsion motor with a stator winding distributed in slots; second, the shunt motor without phase difference which starts as a repulsion motor; third, the series motor without phase difference. The second type, which may be wound for low or high voltages, is suitable for producing a uniform and nearly constant speed; i. e., for high-speed roads. The motor acts as generator and energy is thus given back, as soon as the speed of the motor is higher than the no-load speed. The excitation must not necessarily be single-phase, but this is the simplest arrangement. The first and third motor types mentioned above are alone suitable for traction with varying speed. The advantage of the repulsion motor is that it may be built directly for a high voltage, while the series motor is essentially a low-voltage motor. On the other hand, the series motor has that advantage over the repulsion motor that during starting the magnetizing current of the former is much smaller and may be reduced to zero when the motor has run up to speed. Whether a repulsion motor or a series motor is used, it is necessary to devise a suitable method for regulating the torque. If the voltage supplied to the motor is constant the torque depends only on the position of the brushes on the commutator, with relation to the terminal points of the stator. By a suitable regulation of the brush holder it is thus possible to obtain the positive or negative torque for a certain speed and the effect braking from full speed to stop without any loss of energy. Since the regulation of the brush holder may involve mechanical difficulties, it is preferable not to change the position of the brushes on the commutator, but the points where the current enters and leaves the stator. For this purpose the stator is connected with an apparatus, similar to a commutator, as shown in Fig. 2, and this

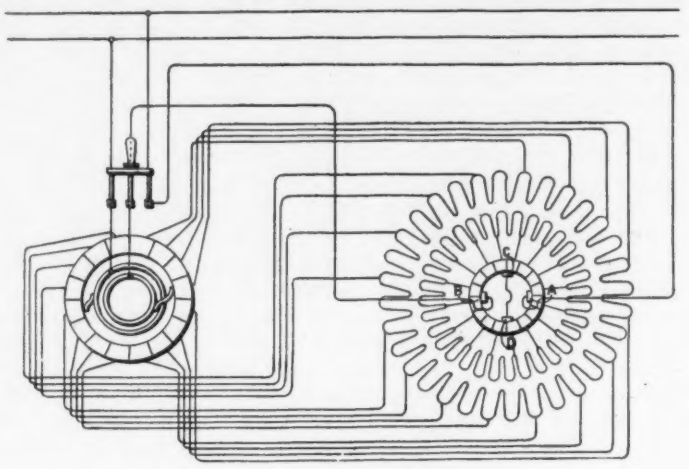


FIG. 2.—DIAGRAM OF CONNECTIONS.

apparatus is placed near the stand of the motorman. The author proposes to discuss the problem of starting without sparks at the commutator in a future article.—*Elek. Zeit.*, December 17.

Alternating-Current Traction.—In an editorial discussion Lincoln's recent paper is said to be a fair statement of the claims for the alternating-current system; on the fact of the showing made, it is thought the general opinion will be that the advantages of the alternating-current system are not sufficient to justify a change from the direct-current system. The main reason why the alternating system is cheaper in first cost is that the current is distributed at very high voltage; but the use of a high voltage is considered to be economy at the expense of safety.—*Eng. News*, December 17.

REFERENCE.

Multiple-Unit Control.—An illustrated description, by Guarini, of the Siemens-Schuckert system in *Elec. Rev.*, December 19. A long illustrated paper, by Niethammer, gives a general review of the subject, with descriptions of the systems of Sprague, General Electric Company, Westinghouse Company and Siemens-Schuckert. In the discussion Adler described the pneumatic control system of Anvert.—*Zeit. f. Elek.*, December 6, 13.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Cut-Outs.—GARRARD.—A communication referring to the recent failure of a British supply station. He does not believe that the insertion of a maximum cut-out in each generator circuit would prevent such a failure, since if a large current is produced and causes one or more of the maximum current cut-outs to open, the current is piled up in the other machines, whose maximum cut-outs would, therefore, open, one after the other, and the entire station would be shut down. He claims that the only automatic cut-out required in a generator circuit is a reverse-current cut-out; this should, however, not be set to operate at too low a reverse current. A safe value would be about 3 per cent. of the full-load current. The only form of proper reverse continuous-current cut-out can take is that of a polarized relay. This can be adjusted to operate at any exact value

of reverse current, and will not operate under any other conditions. The actuating apparatus for knocking out the switch is a tripping coil, the circuit of which is made by the relay. The current for energizing the tripping coil can be taken from an external source, which is the better way, or it may be taken from the same bus-bars that the generators are feeding. It is easy to construct the trip coil with such a large factor of safety that it has sufficient power to open the switch, even if the bus-bar voltage is only ⅕ of the normal value. In an editorial note on this subject doubt is expressed whether central station engineers will share the author's views as to the superiority of the reverse-current cut-outs over other protective devices for direct-current dynamos. The reason of the antipathy of practical men to minimum and return-current cut-outs is that in practice it is found that they occasionally cut off the undamaged generators. In the case of a generating station of fairly large size, there is little danger in using maximum cut-outs between the dynamos and the bus-bars.—Lond. *Elec.*, December 18.

Durban.—The conclusion of the illustrated description of the traction and lighting system of Durban in South Africa. There are 17 miles of tramway track and a negative booster cable has been provided. To meet the large demand for motive power, some 6¼ miles of special motor mains have been laid in various places in town for a 500-volt direct-current supply with switch boxes, which are interconnected to the traction switch boxes, the rails being also used as the return. Where motor mains are laid in streets off the tram routes, a bare copper return has also been laid connected with the nearest rail. The motor mains are also made use of for the street arc lighting; the cables for the various circuits are taken from the nearest switch box up the traction pole, where they are connected to the bare overhead mains; there are about 6 miles of streets so lighted by 155 lamps, arranged in groups of five in series, with a resistance between the last lamp and the rail connection for the return circuit. For the lighting system alternating current with high-tension transmission is used; there are 14 transformer stations, containing transformers mostly of 30 kw.—Lond. *Elec. Rev.*, December 18.

Reconstructed and New Central Station.—An illustrated description of the plant of the Electric Light Company at Meriden, Conn. The old equipment consisted of six engines belted to arc machines and Eddy generators having capacities of 25 to 40 kw. These were replaced at seasons of light load by a 150-kw alternator and a 125 and a 225-kw direct-current generator. The prime-movers are all of the vertical compound type and can be controlled from the boiler room or from the engine room. Prior to the reconstruction the line losses averaged about 20 per cent. and the losses from the engine cylinder to the switchboard 30 per cent. By substituting enclosed for open-arc lamps, the line losses were reduced one-third, and by changing from direct-current series to alternating-current series, the total efficiency of the plant was raised to over 75 per cent. This system was installed for street arcs and the commercial arcs were transferred to a three-wire direct-current system so as to place them more under the control of the customer, and upon a meter rather than upon a contract basis. The old three-wire, 220-volt system was retained for the incandescent lamp service, but the losses between the station and the distributing centers were considerably reduced by the addition of more copper. The power service is almost entirely upon this system, and where this service assumes large proportions special feeders are run from the station in order to prevent fluctuations upon the lighting mains. The power factor of the arc light system averages from 70 to 75 per cent.—*Am. Elec.*, December.

Bradford.—The first part of a fully illustrated article on recent extensions of the Bradford central station, which was the first municipal lighting station in England, having started supply in 1899. A system for hiring out motors is in use, which has met with success, since at the end of 1902 some 641 motors were on hire out of a total of 913 motors, representing 4,398 hp connected. The latter figure has since grown to nearly 5,000. The new generating station contains 14 high-speed engines, with a total horse-power of 6,500; there are six 700-amp., 230-volt balancers on the lighting network; six 700-hp compound generators, giving either 750 amp. at 500 to 550 volts for traction or being run as shunt machines across the outers of the lighting network at 460 volts; and for 300-hp machines, which may be used the same way. In the evening, when the traction plant is closed down, a 100-kw motor-generator is used for transforming lighting current for traction service.—Lond. *Elec. Rev.*, December 18.

REFERENCE.

Charging for Electrical Energy.—CRAPPER.—A paper read before the Leeds Section of the (British) Institute of Electrical Engineers. He discusses the principles of the uniform meter rate and of two-rate meters. If a central station could operate at an approximately constant load for 24 hours per day, the service would be an ideal one and the uniform rate would be the ideal rate; but at present a uniform rate for all purposes and at all times is not only impracticable, but unjust. He advocates a differential rate in some form as the most workable system provided the initial rate is not too high.—Lond. *Elec.*, December 18.

WIRES, WIRING AND CONDUITS.

High-Tension Porcelain Insulators.—FRIESE.—An illustrated account of an experimental investigation. On high-tension lines, porcelain insulators behave like condensers, the wire corresponding to one plate, the earth to the other plate of the condenser and the porcelain mass to the dielectrics. The capacities of these condensers are to be considered to be connected in parallel among themselves and with the capacity of the transmission line against earth. The author has tested two different types of insulators, the results being given in tables and diagrams. The capacity of the insulators is small, although not negligible, since it increases the capacity of the line itself against earth by a few per cent. The capacity and dielectric constant were found to be independent of the voltage for both insulators. For one insulator the loss was found to be proportional to the square of the voltage, while for the other insulator type tested it was proportional to about the 226th power of the voltage.—*Elek. Zeit.*, December 17.

REFERENCES.

Losses in High-Tension Cables.—ROTH.—A communication referring to the investigation of Apt and Mauritius, recently abstracted in the Digest. He doubts whether the "loss figures," given by them for various insulating materials, are an exact indication of their quality, since the authors have not correctly taken into account the thickness of the insulating layer. He believes that their method of testing insulating materials gives correct results only when cables with equal cross-section and with equal thickness of insulation are compared.—*Elek. Zeit.*, December 17.

Cables of South Africa.—An illustrated article on the change which is now being made in Johannesburg from overhead electric wires to underground cables. The high-tension voltage is 3,000, while the low-tension distribution is by three-wire network with 400 volts across the outers. At present 15 miles of underground cables have been laid and this change is to go on steadily.—Lond. *Elec. Rev.*, December 11.

ELECTRO-PHYSICS AND MAGNETISM.

Stationary Electric Waves.—MOLLOY.—A paper read before the Dublin Section of the (British) Institution of Electrical Engineers. The experimental apparatus used by the author consisted of an induction coil giving from 20,000 to 30,000 volts, two Leyden jars, arranged so that the capacity of the circuit might be varied by placing them in series or parallel, and two coils, the self-induction of which could be varied within wide limits by means of sliding-contact pieces. The frequency of the oscillations was of the order 100,000 to 1,000,000 periods per second, and the number of oscillations in each single spark was 8 to 10. An analogy was drawn between an organ pipe and an electric radiator, in both of which the minimum changes of pressure occur at the open end and the maximum at the closed end. Though the principle of resonance will protect the secrecy of wireless telegraphy messages over a very large area near the receiving station, there always will be an area near the transmitting station over which resonance cannot afford complete protection. He showed this by bringing an untuned receiver into the neighborhood of the transmitter. As it approached the radiator, the receiver responded fully to waves emitted, and successfully tapped the message. The second part of the paper dealt with the higher harmonics, and for their exhibition a long vertical coil was used. A vacuum tube was placed in the field of this coil and the oscillator circuit was first tuned to the fundamental of the coil, the bottom of which was connected to earth; an effect as of a web of light, intense at the upper part, and gradually fading towards the bottom, took place when stationary electric waves were set up in the coil. Subsequently the oscillating circuit was tuned successively to the first, second and third harmonics of the fundamental proper to the coil, and the maxima and minima of the luminous discharge were evident. In

these experiments the upper end of the coil was insulated, in which condition it follows the laws of a closed organ pipe, producing only odd partials; that is, n, $3n$, $5n$ vibrations per second. By connecting the upper end to earth it is possible to produce all the partials, n, $2n$, $3n$, etc.—Lond. *Elec.*, December 18.

Radium and Atomic Theories.—RAMSAY.—A short summary of our knowledge on radium. Concerning the transformation of radium into helium, he makes the following remarks: Just as there is a limit to the possible number of atoms in a compound of carbon and hydrogen, so there may be a limit to the atomic weight of an element. Those elements with high atomic weight, such as thorium, uranium and radium, are apparently decomposing into elements with low atomic weight; in doing so they give off heat and also possess the curious property of radioactivity. What these elements are is unknown, except in one case; one of the products of the decomposition of the emanation from radium is helium. Whether the process be reversed, no one knows. If gold, which has a high atomic weight, is changing, it is much more likely that it is being converted into silver and copper than is being formed from them. At this stage, however, speculation is futile. More experiments are required.—From Lond. *Mail* in *Scient. Am.*, January 2.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Formation of Lead Peroxide from Lead.—ROKOTNITZ.—A long article giving the results of laboratory tests on the electrolytic production of lead peroxide from lead with various electrolytes. With acid solutions the efficiency was better than with alkaline solutions. In pure sulphuric acid solution the output, however, is very small, but improves if such substances are added which first produces another lead compound from which peroxide can be formed more easily. He obtained the best results with an electrolyte containing 46.7 grammes of potassium sulphate and 30 grammes of potassium chlorate, in which case the ampere-hour efficiency of the peroxide formation was over 80 per cent.—*Centralblatt f. Accüm.*, September 15, October 1, 15; November 1, 15.

Electrogalvanizing.—GRABRAN.—A description of some experiments made on plating zinc on iron, especially for plating the sides of vessels with zinc. He obtained the best results with a solution containing 6,000 grammes of water, 1,200 grammes of zinc sulphate and 60 grammes of sulphuric acid of 24° Baume. With a current density of 6 amp. per square decimeter and circulation of the solution the ampere-hour efficiency is nearly 100 per cent. An apparatus for plating the sides of a vessel with zinc is described which is essentially a nozzle through which the electrolyte is circulated, and which is pressed against the side of the vessel, the latter being, of course, the cathode. It is especially important that any soldered places should be plated with zinc as otherwise a galvanic action is set up.—*Elek. Zeit.*, November 12.

REFERENCES.

Electrolytic Formation of Lead Peroxide from Lead.—PETERS.—Continuations of his long serial giving the results of laboratory tests on the use of various electrolytes for the electrolytic formation of lead perxide from lead. No summary is yet given.—*Centralblatt. f. Accum.*, December 1, 15.

Electrodeposition of Copper.—COWPER-COLES.—A long article giving brief illustrated descriptions of various processes for plating iron and zinc with copper.—*Electrochem. and Met.*, November.

Electrolytic Drilling.—COWPER-COLES.—An illustrated description of an electrolytic drilling and slotting process. A nozzle is placed against the plate to be drilled. The electrolyte is circulated in the nozzle. The metal to be drilled is the anode and a solution of sulphuric acid is the electrolyte.—*Electrochem. and Met.*, October.

Galvanic Cells.—BERTHELOT.—A translation of some of his recent papers on the theory of galvanic cells; one refers to the "relation between the intensity of the voltaic current and the manifestation of the electrolytic output"; the second to "manifest electrolytic actions developed by batteries constituted by the reaction of two liquids, one containing an acid, the other an alkali"; the third to "new experiments on the limit of intensity of the current of a battery corresponding to the manifestation of an exterior electrolytic output apparent in a voltameter."—*Sc. Am. Sup.*, December 26.

Physico-Chemical Review.—The first number of a new journal with the title, *Physikalisch-Chemisches Centralblatt*, has just appeared, in which no original articles will be published, but abstracts given of all the original articles published in various countries in the field of physical chemistry. As far as possible the abstracts will be furnished by the authors themselves and will, therefore, be printed either in German or English or French. The editor is M. Rudolphi.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electric Thermostat.—DARWIN.—A (British) Physical Society paper, in which he describes an electric thermostat. The vessel, the temperature of which is to be maintained constant, is surrounded by oil contained in a bath. In the oil are placed two heating coils through which electric currents pass. By automatically controlling these currents, the temperature of the oil and consequently of the inner vessel, is kept very nearly constant. The control is effected by means of a Wheatstone bridge in the outer oil bath. This bridge has two opposite arms of copper and two of manganin, so that it is only balanced at some definite temperature. Its deviations from balance affect the position of a long horizontal boom attached to the suspended coil of a galvanometer. The position of the boom determines the greater or less descent of a "hit or miss" arm, which is periodically raised by a rotating cam, and can only fall to its lowest position when the galvanometer boom is to one side and allows it to pass. This position of the boom corresponds to a fall of temperature of the controlling bridge. Thus the position of the "hit or miss" arm at its lowest position depends on the temperature, and it is the variation of this position which regulates the amount of current passing through the heating coils. When the "hit or miss" arm is at its highest position, the galvanometer boom is absolutely free to move to its position of equilibrium. At every rotation of the cam the "hit or miss" arm is lowered, and if it passes the galvanometer boom a key is closed and a current passes through the "intermittent" heating coil. The current passing through the "permanent" heating coil is also automatically regulated. This apparatus is capable of keeping the temperature within 0.01° C. for a period of eight hours.—Lond. *Elec. Rev.*, December 18.

Electromagnetic Units.—E. H.—With reference to Kennelly's Institute paper and the recommendations made for the Saint Louis Electrical Congress, the writer expresses the opinion that sooner or later the c.g.s. system will become the international system of units. The metric system from which it is derived is incoherent, since the unit of density does not conform with the units of mass and volume. The fundamental unit of force varies on different points of the earth. What he says against the metric system is also to be said against the practical c.g.s. system. The absolute c.g.s. system is itself not free of fault, but represents, as Kennelly shows, the least imperfect and most coherent system. All units should get names. The nomenclature proposed by Kennelly is considered to be very simple. The editor opens the columns of his paper to a discussion of the subject.—*L'Ind. Elec.*, December 10.

REFERENCES.

Integrating Wattmeter.—An illustrated article on the construction of the Stanley wattmeter and the equipment of the Stanley Instrument Company's works.—*Elec. Rev.*, December 12.

Magnetic Vane Voltmeter or Ammeter.—BROCKSMITH.—An article, with working drawings, on the construction of a magnetic vane voltmeter or ammeter. The instrument is extremely simple, both in principle and construction, and has the advantage of being compact and neat in appearance, while being sufficiently accurate for all ordinary purposes. The article is replete with dimensioned detail drawings and all the information necessary for the building of the instrument.—*Am. Elec.*, December.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Simultaneous Telegraphy and Telephony.—PFITZNER.—An illustrated description of a system of connections which has been used for several years on several telephone double lines between Brussels

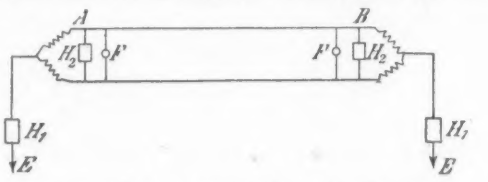


FIG. 3.—DIAGRAM OF GENERAL CONNECTIONS.

and Paris, and which enables one to telephone and simultaneously exchange telegrams between two pairs of Hughes apparatus. The general scheme of the connections is shown in Fig. 3, in which $H_1 H_1$ is the one pair and $H_2 H_2$ the other pair of Hughes apparatus; $F F'$

are telephones and *E* is the earth. A modification of this scheme has also been used wih success by the German telephone department. The details of the connections are described and also given in form of diagrams.—*Elek. Zeit.*, December 17.

Magneto Switchboard for Small Exchanges.—O'BRIEN.—Telephone switchboards of the magneto type, in which the talking current for the sub-station instruments is furnished by local batteries located at each sub-station, have been almost entirely superseded in all the large and medium-sized exchanges in the country by the central energy common-battery type of switchboard. In a great number of small exchanges, however, where the expert attendance and supervision necessary for a common-battery board are not available, the simplicity and freedom from complicated circuits of the magneto board renders it especially suitable, and consequently this type of board is in use in small country exchanges to a very great extent. The author describes the wiring circuits, equipment and method of operation of a magneto switchboard having a capacity of 100 sub-station lines, which with the system in vogue in country exchanges is capable of serving as high as 400 to 500 sub-stations.—*Am. Elec.*, December.

Rapid-Type Printing Telegraph.—A note on an apparatus of Siemens and Halske based on the following principle: A disc, near the periphery of which the letters of the alphabet, figures, etc., are cut out, rotates at a speed of 2,000 r.p.m. between a moving strip of sensitive paper and a spark-gap. Every time the spark jumps the gap, that letter on the disc which happens to be at the time opposite the gap is photographed; 2,000 letters per minute may thus be recorded on the moving tape, which passes through a developing and fixing bath, out of which it emerges after about 9 seconds. To obtain good results, the spark, it is said, must occur with a punctuality by 1/400000f a second, and this has been attained by a suitable arrangement of condensers. The messages to be sent are first punched on tape, which is then rapidly run through a rotating sender by means of which corresponding current impulses in rapid succession are sent to the line.—Lond. *Elec.*, December 18.

Printing Telegraph Central Station.—GRADENWITZ.—An illustrated description of the type-printing telegraph service, recently added to the Berlin telephone service. The instrument used is a teletypewriter and the station is used at present to transmit exchange telegrams to a certain number of subscribers. It is, therefore, in the nature of our stock-ticker. The same system may, of course, be employed for transmitting telegrams from a central telegraph office to a certain number of newspaper offices.—*Sc. Am.*, December 26.

MISCELLANEOUS.

Welding Aluminum.—COWPER-COLES.—An illustrated description of various processes for welding aluminum and especially of his own machine for this purpose. The aluminum to be welded is first pre-heated and then the ends to be welded are pressed together so that a ring of metal is squeezed out, which is largely composed of aluminum oxide and acts as a supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle, which allows water under pressure to be projected on the joint from a reservoir. The collar around the joint is afterwards filed off.—*Electrochem. and Met.*, November.

REFERENCE.

Siberia.—An article on electricity in Siberia. Six central stations are mentioned. The best equipped is at Tomsk, where "the maximum electrical output is 2,500 kw-hours per day." While there is nothing to learn from Siberian electrical engineering, yet their trade is worth having.—*Elec. Rev.*, December 12.

New Books.

THE DYNAMO. Its Theory, Design and Manufacture. By C. C. Hawkins, M.A., M.I.E.E., and F. Wallis, B.A., A.M.I.E.E. New York: The Macmillan Company. 413 illustrations.

The third edition of this book on the dynamo has been greatly enlarged, and its pages are replete with instruction. Through the general theory of the magnetic field and the production of e.m.f., the authors lead up to the dynamo in its modern form, and present their subject in a manner thoroughly up to date. It is gratifying to see how scrupulous the authors have been in mentioning the sources from which they have drawn, a custom which, in these days of literary piracy, deserves appreciation. The citation of the sources from which an author has drawn is not only a debt that he owes, but it is often extremely useful that the reader may be able to turn to the original pages for further information, and, therefore, the modern careless way of not stating the sources is greatly to be deprecated.

The eighteenth chapter treats of the theory of commutation, to which Mr. Hawkins has been a valuable contributor for many years. It is to be regretted that he does not give the theory of commutation at greater length. The chapters on the heating of dynamos and on armature reaction in alternators are excellent, the latest theoretical and experimental results having been considered. A passage from the author's preface shows the scope of the book, and we therefore cite it here: "At the same time the utmost economy in the materials and labor employed in the manufacture of a machine is imperatively called for in order to meet the increasing keenness of a world-wide competition; every pound of copper and of iron must be utilized to its fullest extent, and designs involving high-priced skilled labor must give way to simple types having easily-made interchangeable parts, with the consequent result that the machines for given outputs are smaller and more standardized. Thus in preparing a third edition it became necessary to rewrite most of the former chapters and to add several new ones."

The chapters on dynamo construction give a number of very fine cuts of modern dynamos of European and American makes, and the book as a whole will prove instructive and of interest to electrical and mechanical engineers.

Record Run of Electric Automobile.

Mr. Fred B. Whitney, clerk to the Committee on Naval Affairs of the House of Representatives, established the world's record at Washington, D. C., December 23, 1903, for an endurance run at the highest long-distance speed of an electric auto upon a single charge of storage battery. President A. L. Cline, of the local Automobile Association, acted as referee. The start was from the Dewey Hotel at 7.05 P.M. Tuesday night, December 22, in an electric Stanhope equipped with a 570-pound Porter battery and the run was made upon the streets of Washington. At 5.20 Wednesday morning the Stanhope collided with a heavy covered wagon, spilling considerable battery fluid, tearing off a tire, breaking spokes and springing axles, etc., and was hauled to a repair shop. A distance of 107.4 miles was

ELECTRIC AUTOMOBILE.

made in the actual time of 9 hours and 12 minutes, or about 12 miles per hour. The longest runs without shutting off current were 31, 23 and 21 miles. At 2 P.M. Wednesday after hasty temporary repairs had been completed the run was resumed and 13.8 miles were made in 1 hour and 30 minutes under the difficulties of a disordered machine. The Stanhope was run to its garage under its own power and showed a voltage of over 1.8 per cell and could have made more miles without accident. The total distance run was 121.2 miles in 10 hours and 32 minutes, or about 12 miles per hour. This establishes a world's record for long-distance run upon a single charge at the rate of 12 miles per hour and raises the long-distance rate one mile per hour. The world's record at 11 miles per hour was made at Cleveland, 1902, at 151 miles. The world's record at 10 miles per hour was made by Mr. F. C. Phillips, of Cleveland, at Chicago at 187 miles, using Porter battery.

New Types of Voltage Regulators for Generators.

The General Electric Company has recently placed on the market two new types of voltage regulators, designed for direct-current generators only (Fig. 1), and the other (Fig. 2), though primarily

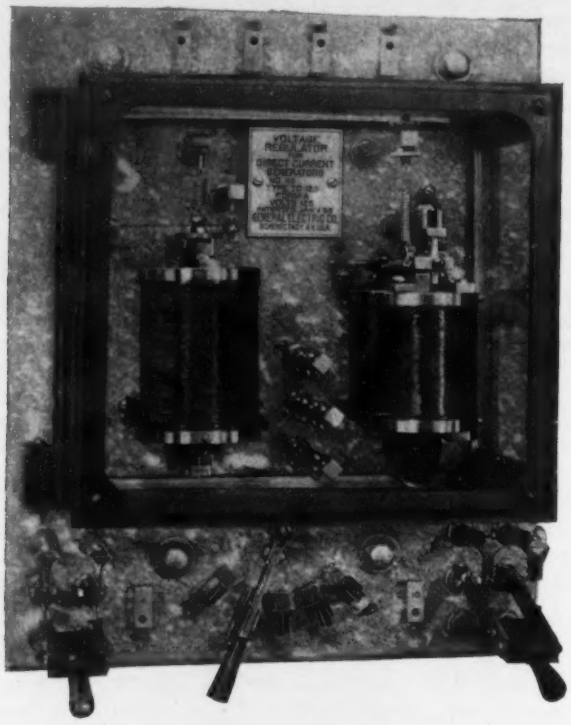


FIG. 1.—DIRECT-CURRENT REGULATOR.

designed for use with alternating-current generators, may, if provided with an exciter, be used on direct-current generators as well.

These instruments operate on the principle of rapidly opening and closing a shunt circuit across the field rheostats, the rheostats having considerable resistance turned in to give the regulator a good margin to work on. The first mentioned type is arranged to open and close

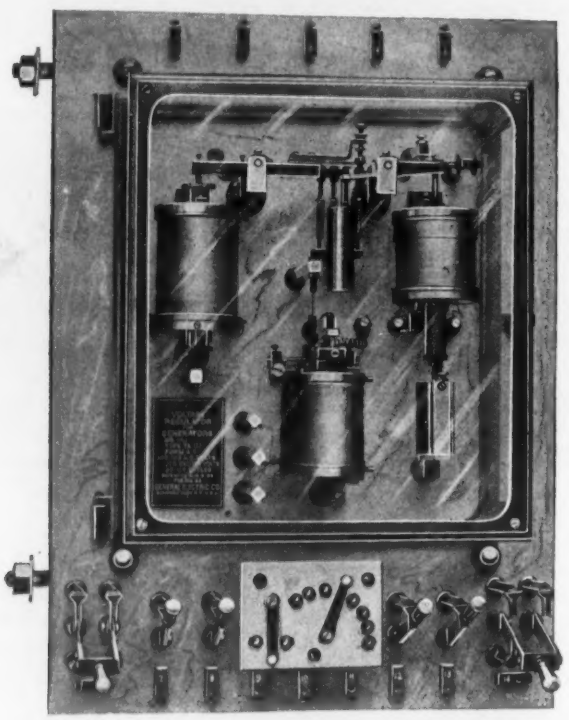


FIG. 2.—ALTERNATING-CURRENT REGULATOR.

a shunt circuit across the generator field rheostat, and the other across the exciter field rheostat.

The direct-current regulator consists of a main control magnet and relay. The relay is differentially wound, one of these windings being permanently connected to the circuit, while the other is opened and closed by the main contacts which are operated by the main control magnet. As the main contacts are opened and closed, they simultaneously open and close the relay contacts by means of the differential winding of the relay. These relay contacts open and close a shunt circuit across the generator field rheostat. To prevent injurious sparking at the relay contacts, condensers are connected in multiple across them. This regulator will maintain constant voltage on one shunt-wound generator, or will maintain constant volt-

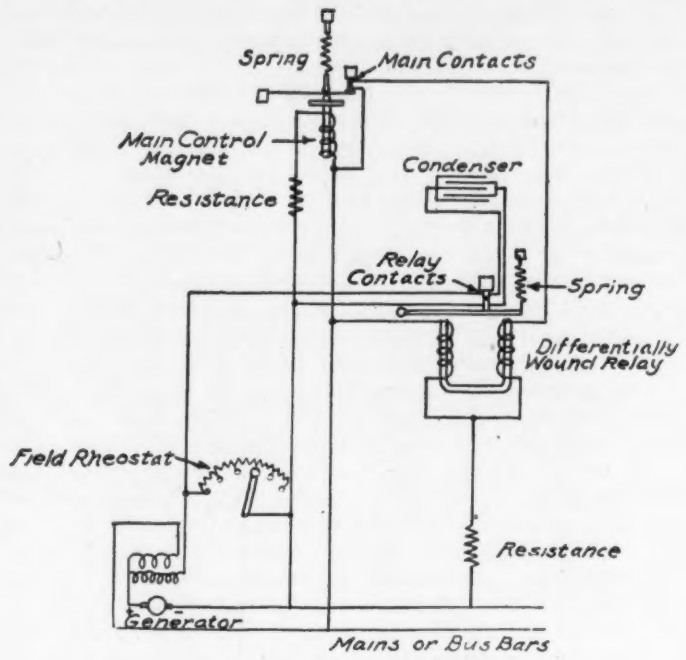


FIG. 3.—DIAGRAM OF CONNECTIONS.

age on several compound-wound generators operating in parallel, regulating, however, only one at a time. Several generators can be arranged to be controlled by one regulator, by means of the five-point

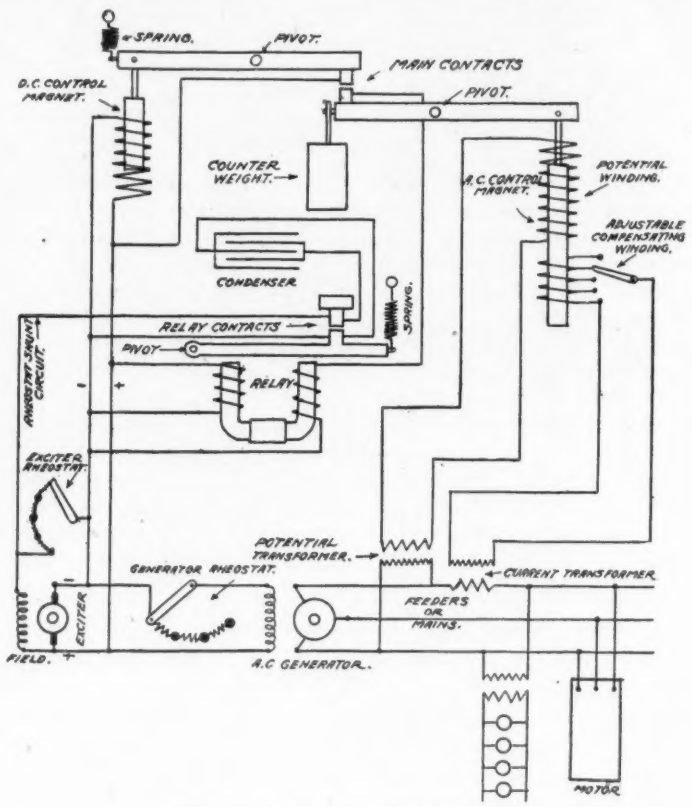
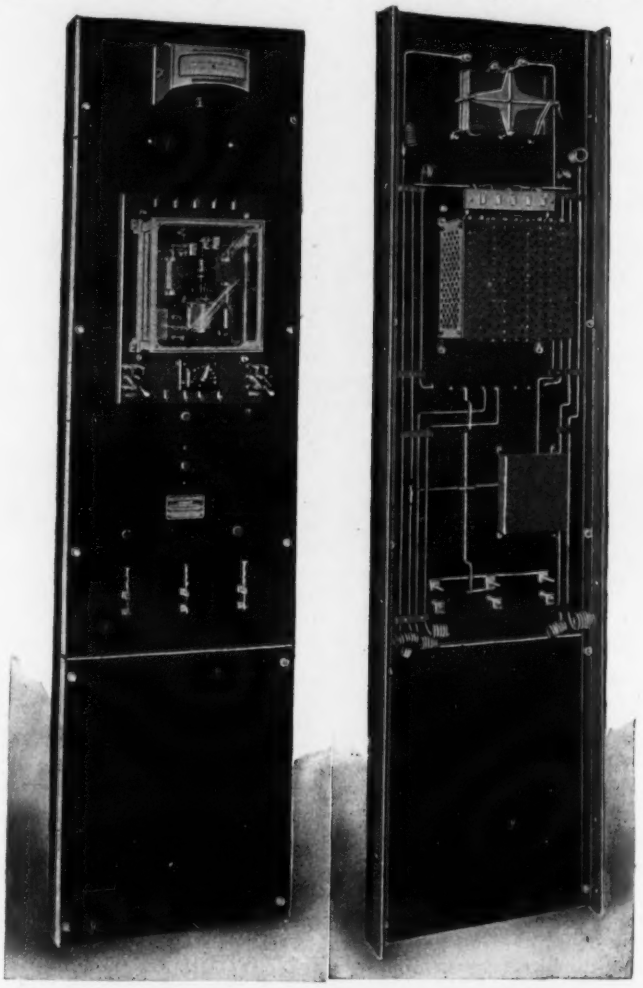


FIG. 4.—DIAGRAM OF CONNECTIONS.

rotary switch as shown in Fig. 1. The generator being regulated has a tendency to take the sudden fluctuations of load, but it is quickly equalized between the several generators by means of the compound winding of the machines. With shunt wound generators it will be necessary to have a regulator for each generator to be regulated.

These regulators are usually arranged to maintain constant voltage at the bus-bars, but may be connected to pressure wires brought back from the centre of distribution, thus maintaining constant voltage at the centre of distribution. The connections of this regulator are shown in Fig. 3.

The second type of regulator is designed to maintain a steady (but not a constant) exciter voltage, and consists of the same direct-current control magnet and relay as the direct-current type with the addition of an alternating-current control magnet having a potential and an adjustable compensating winding. These two windings work in opposition to one another. This magnet operates the lower main contact. The magnet core and lever are arranged by means of a counterweight to come to a balance at the correct voltage. Should the alternating voltage tend to vary for any cause, it would change the position of the lower main contact, which would cause the exciter voltage either to be raised or lowered, thus overcoming the disturbing factor. Without the use of the compensating winding, the regulator will maintain a constant bus-bar voltage, and by the use



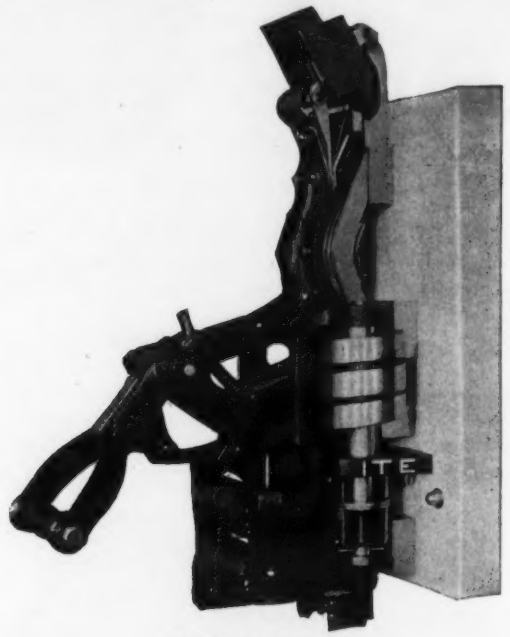
FIGS. 5 AND 6.—FRONT AND REAR VIEWS OF REGULATOR PANELS.

of the adjustable compensating winding and current transformer in the circuit to be regulated, the regulator will automatically compensate for line losses. The alternating voltage is automatically kept at its desired value by varying the exciter voltage. Once the regulator is adjusted to maintain constant voltage at the centre of distribution it will require no further adjustment, and the station voltage will be increased or decreased with the load to automatically maintain the desired voltage at the centre of distribution. This regulator is independent of temperature and frequency changes. Elementary connections are shown in Fig. 4.

These regulators are switchboard instruments in design and finish, and may be placed on the front of a switchboard panel or be placed at either end of a switchboard on rigid iron brackets made for that purpose, Figs. 5 and 6. The value of these regulators will be recognized in maintaining the desired potential on a system, regardless of variations of speed and load. It naturally results in reduced attendance at the switchboard, increased output of station and reduced lamp renewals due to perfect regulation. It is stated that there are now in service regulators of these types controlling upwards of 100,000 kw of generating apparatus.

Reverse Current Circuit Breakers for Protection of Generators in Parallel.

One of the latest types of I. T. E. automatic circuit-breakers, designed and manufactured by the Cutter Company, of Philadelphia, is the overload and reverse-current type, illustration of which is shown herewith. This circuit-breaker is especially serviceable for the protection of generators operated in parallel. In the electric railway power plant, or the lighting plant in a hotel, office building or department store, there is a time of day when the load comes on very rapidly, due to increased traffic or turning on of lights. At such a time the engineer has to start up an extra generator and throw it in parallel with the generators already carrying the load. The load, however, often increases so rapidly that the dynamos running are greatly overloaded before the extra machine can be cut into the circuit to carry its part of the load. If an engineer in his excitement, to get this generator into service, should attempt to throw it in parallel with the other generators before it is up to voltage, the ones carrying the load would also have to supply current to run this gen-



CIRCUIT-BREAKER.

erator as a motor until it was up to speed. This extra load at such a time would seriously overload the plant and possibly open the overload circuit-breakers on the generators.

To guard against such careless handling of generators, and also against open fields, etc., a reverse-current circuit-breaker is used, or rather a circuit-breaker combining the overload and reverse-current features. The reverse-current provision automatically opens the circuit-breaker on any specified reverse current, and the instrument can be provided with a calibrated scale so that it can be set to open when the reverse circuit exceeds a predetermined point. The tripping force is dependent upon the amount of reverse current and the greater the current the quicker the circuit-breaker is opened. The operation is practically independent of the voltage on the line and will open the circuit, even though the voltage fall to 25 per cent. of normal. The overload feature is the same as that used with other types of I. T. E. circuit-breakers and is positive and accurate in its calibration.

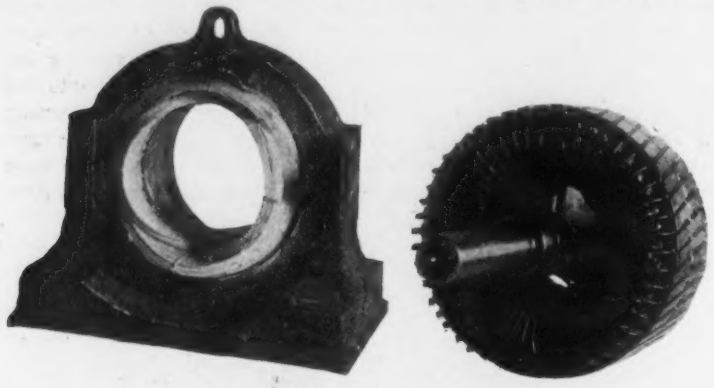
This type of circuit-breaker is also largely used for the protection of rotary converters operated in parallel. They are built plain reversal and overload and reversal in all capacities, single and double-pole, up to 12,000 amp., for use on circuits of any voltage up to 800 volts, direct current. Smaller types are used for the protection of electric automobile charging circuits and storage battery equipments of all kinds.

Freeport-Dixon Electric Railway.

The Arnold Electric Power Station Company, engineer and contractor, Chicago, Ill., has been retained by the Freeport-Dixon Electric Railway Company to prepare preliminary plans for its proposed line. The road will consist of about 35 miles of single track, and will connect the cities of Freeport and Dixon.

British Single-Phase Motor.

The Langdon-Davies Motor Company, Ltd., London, has for many years made a specialty of single-phase alternating-current motors, although they also make and supply direct-current, two-phase and multiphase motors. Their alternating-current motors, as regards the larger sizes, have a special construction of bed plate. This has the advantage of serving instead of slide rails, and further has the manufacturing advantage of reducing the size and weight of the pieces to be machined. As slide rails, it carries the weight in the plane of the motor axle and thus reduces the tendency to cant, especially with a



FIGS. 1 AND 2.—FIELD AND ARMATURE.

horizontal belt drive, and the protections on either side of the sliding part entirely avoid any sideways cant when tightening up the belt.

The fact that the above company are turning out over 2,000 hp of single-phase motors a year, and that in many cases factories have abandoned their gas and steam engines and replaced them by such motors to the extent of 200 or 300 hp, and are pleased with the result, forms a significant comment on the development effected. At Derby, which is a network having a single-phase supply, the consumption of energy for motive power for the year ending last March was 22 per cent. of the total units sold. This is a figure which will

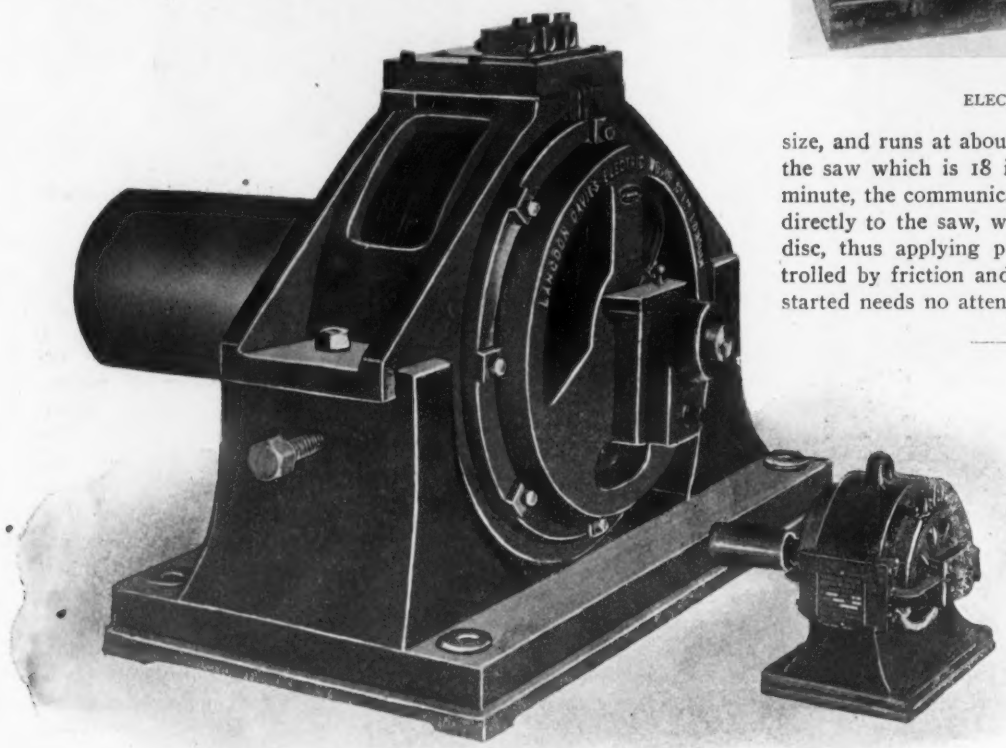


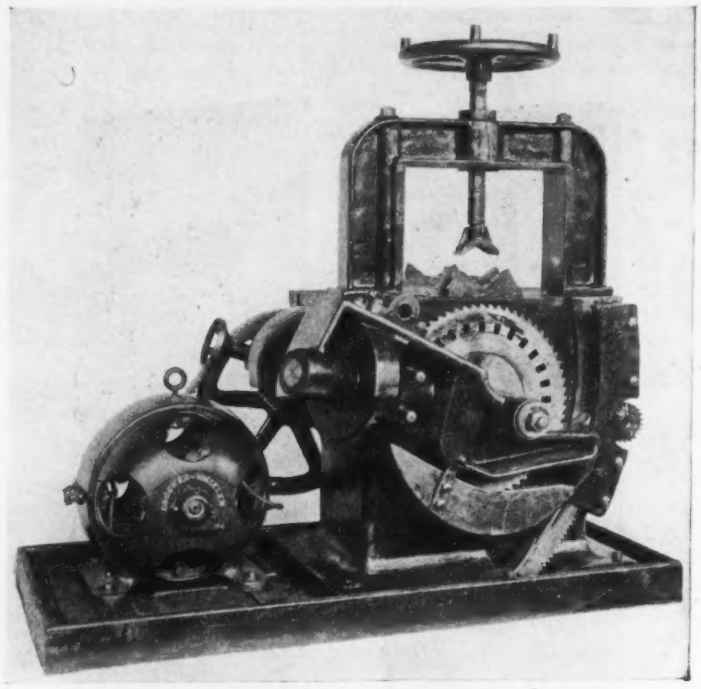
FIG. 3.—SINGLE-PHASE MOTORS.

be found to compare very well with any direct-current station of a similar size.

The repairs and renewals of the induction motors, especially those without slip rings, which can be adopted for nearly all purposes, are an almost nominal amount. The accompanying engravings show the windings of the rotor and stator of the smaller motors.

A Motor-Driven Cold Metal Saw.

A portable cold metal sawing outfit is illustrated herewith. It is a standard Higley saw, designed for cutting bar stock, to give lengths at a rapid rate, and is marketed by the J. R. Vandyck Company, of New York. The distance between the uprights of the clamp is 16 inches and the height under the arch of the clamp is 12 inches. The tool is capable of cutting round stock up to 7 inches in diameter, 12-inch I-beams, etc. The drive was arranged by substituting a sprocket for the belt pulley and connecting to the motor by a Renold silent chain. The supporting frame of the saw is swiveled about the sprocket shaft as an axis, and feeding is accomplished by swinging the saw up under the work, the feeding and returning being automatic. The motor is of the Crocker-Wheeler make, of 3-hp



ELECTRICALLY-DRIVEN METAL SAW.

size, and runs at about 725 h.p.m., when on 120 volts. At this speed the saw which is 18 inches in diameter makes about 4½ turns per minute, the communication being through a spur gear and bevel gear directly to the saw, where a sprocket engages in perforations in the disc, thus applying power very near the teeth. The feed is controlled by friction and is adjustable so that the machine when once started needs no attention until its job is finished.

Test in Wireless Telegraphy.

On the morning of Saturday, December 5, an interesting test in wireless telegraphy was made between Fort Wright, New London, and Fort Schuyler, New York, a distance of about 100 miles. The test was made by the De Forest Company on behalf of the Government. Three messages of about thirty words apiece were sent by General Greely, of the United States Signal Corps, from Fort Wright to Captain Reber at Fort Schuyler. The particular interest of thetest lies in the fact that certain conditions were imposed which made it very difficult to send a distance of 100 miles, namely, the height of the antennæ at the two stations was limited to 140 feet, and the power at the sending end to 3 kilowatts. The Government is erecting two stations in Alaska about 100 miles apart, and General Greely wished to satisfy himself that messages could be transmitted over this distance under the conditions stated. A number of army officers witnessed the test.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Improvement was the feature in the stock market throughout the week, but there was a sharp reaction at the close. Financial conditions are considered sound and healthy. Money is in good demand for legitimate purposes, and the supply resulting from the release of funds engaged in crop movement, with some $25,000,000 of foreign gold imported, gives promise of abundant ease in the future. Amalgamated Copper was heaviest among the active stocks, and lost 4¾ per cent. Its decline was a depressing influence upon other stocks on account of its recognized relation to the Standard party. The traction and electric securities all show advances on a fairly good business, the greatest relative activity being in General Electric, of which 12,460 shares were sold at prices ranging from 171½ to 180, the closing figure being 176, a net gain of 4½ points. Activity is also noted in Westinghouse common, 18,000 shares having changed hands, the extreme prices being 168 and 180, the former being also the closing quotation, ex.-dividend, and representing a net gain of 2½ points. The preferred stock gained ½ point net, closing at 193½. In tractions B. R. T. closed with a net loss of 4⅛ points, the last price being 48¾. Metropolitan Street Railway closed at 121½, being a net gain of 1⅝ points. American Telephone & Telegraph closed with a gain of 2⅛ points, at 128⅛, and Western Union at 86½, a ¼ point better than the last previous record. Following are the closing quotations of January 5:

NEW YORK.

	Dec. 29	Jan. 5		Dec. 29	Jan. 5
American Tel. & Cable	80	80	General Electric	176	173
American Tel. & Tel.	128⅛	125	Hudson River Tel.	..	..
American Dist. Tel	24	24	Metropolitan St. Ry.	125⅝	122¼
Brooklyn Rapid Transit	54	49⅛	N. E. Elec. Veh. Trns.	..	..
Commercial Cable.	..	..	N. Y. & N. J. Tel.	..	..
Electric Boat	15	15	Marconi Tel.	25	..
Electric Boat pfd.	40	46	Western Union Tel.	86⅛	86
Electric Lead Reduction.	1	1	Westinghouse com.	175⅛	168
Electric Vehicle	5¼	7⅝	Westinghouse pfd.	190	185
Electric Vehicle pfd.	9	11¾			

BOSTON.

	Dec. 29	Jan. 5		Dec. 29	Jan. 5
American Tel. & Tel	128	128⅛	Western Tel. & Tel. pfd.	78	78
Cumberland Telephone	*114¼	*114⅛	Mexican Telephone	1½	1½
Edison Elec. Illum.	232	231	New England Telephone	121	*122
General Electric	176	171	Mass. Elec. Ry.	20	19½
Western Tel. & Tel	7⅛	8	Mass. Elec. Ry. pfd.	75¾	75¾

PHILADELPHIA.

	Dec. 29	Jan. 5		Dec. 29	Jan. 5
American Railways	43⅛	43⅛	Phila. Traction	97¾	..
Elec. Storage Battery	54	56	Phila. Electric	6	5⅞
Elec. Storage Battery pfd.	54	56	Phila. Rapid Trans.	8⅝	8¼
Elec. Co. of America.	8⅛	..			

CHICAGO.

	Dec. 29	Jan. 5		Dec. 29	Jan. 5
Central Union Tel	..	..	National Carbon pfd.	92	92
Chicago Edison	..	..	Metropolitan Elev. com.	17	17
Chicago City Ry.	155	..	Union Traction	6¼	6¼
Chicago Tel. Co.	..	..	Union Traction pfd.	*29	28
National Carbon	20⅛	21			

*Asked

BELL TELEPHONE.—A Boston telephone official is quoted as follows: "I believe the result of President Fish's recent visit to the West will be an active campaign during the coming spring against the independents in the Middle West with a view of preventing their increasing their hold upon the city of Chicago. The battle will take place in the territory of the Central Union Company in the Middle West, where competition is the hottest and the field that General Sabin, of San Francisco, attempted to conquer. It will have to be done by funds furnished direct by the American Company, as the Central Union Company is already up to its bond limit and, notwithstanding its stock has been cut in two, the market value is far below 100. All the subsidiary companies with their reports sent to Gen. Thomas Sherwin, auditor, in December, will estimate the cost of next year's extensions and show the amount of money required. Based on the winter orders for poles and cables already placed, the extensions will exceed those of this year on all lines and at least $30,000,000 will be asked for, although the home office may cut this amount on account of the money stringency, to $25,000,000. With Bell stock selling at $126, it is quite probable that the new money will be raised by bond issues instead of selling at 7½ per cent. stock at par. Based upon the recent sale of Atchison bonds and the fact that all the Bell bonds previously issued have been distributed, the company ought to be able to market a block of $25,000,000 to net above 90, basing the rate fixed to be 4 per cent., a saving of say 3 per cent., or $750,000 annually."

GENERAL ELECTRIC.—On the subject of General Electric business in 1903-4, the *Wall Street Journal* says: "We understand that the General Electric will close the year with substantially the same net figures as for 1902. The gross business has been larger, but the expense of material, power and labor has been increased. The electric manufacturing companies are fairly well supplied with orders, but will doubtless enter the year with a reduced amount as compared with a year ago. The problem of high costs at the present time, with the prospects for a falling off in business at the end of the year, must be soon taken up, and it is expected that the orders now in hand can be so judiciously distributed over the year as to meet a reduced output for the whole of the year 1904 with some measure of economy in costs. This may involve a reduction in forces at Schenectady and Lynn and some readjustment of wages. A few departments of the company are still overcrowded, but in others there is a surplus of labor. The problem of 1904 is one of economic readjustments to irregular conditions."

BOSTON STOCK TICKERS.—The announcement is made that the Commercial-Financial Press Association has acquired the Boston *Financial News* and the New England stock quotation service, and through association with the New York News Bureau has become Boston correspondent for that association. By reason of the changes, on and after January 1 the service of the Boston *Financial News* will be conducted directly by the Commercial-Financial Press Association, the absolute control of which is in the hands of an interest closely allied with the New York News Bureau. The new management will install within the next two or three months an electric delivery service by means of the Burry bulletin printer, which has for some years been successfully operated in New York. The publication offices of the new association are at 35 Congress Street, and the business offices at 22 Congress Street. Charles B. Strecker is president and general manager of the company.

B. R. T. LEASE.—It was stated on Wall Street last week, in positive terms and from reliable authority, that the Brooklyn Rapid Transit system had been taken under lease by the Interborough Company on a 4 per cent. guarantee stock. The negotiations have not been closed, it is asserted, because of the insistence of the Rockefeller interests on a demand for an increase of the guarantee to 5 per cent. after a few years. The Interborough people object to an increase in less than ten years. The proposition to lease, however, has been absolutely agreed upon.

Commercial Intelligence.

THE WEEK IN TRADE.—Generally the earnings of the railroads remain good, and while the extreme high water mark may in some cases not be maintained on the majority of roads the reports are encouraging and the handsome surpluses over dividends paid, and the belief that it will be practical to reduce expenses in the future give reason to expect an indefinite continuance of the present rate of distribution, with some increases more than possible. Trade conditions in general are reported favorable, and there is a decidedly hopeful feeling as to new year's business. The extreme cold weather checked retail trade temporarily, but this is a mere seasonable incident, the future outlook being very satisfactory. No particular changes are noted in the iron and steel trade, while the other metals, including copper, remain practically unchanged from the last quotations.

DORTMUND ELECTRIC ROAD.—The commissioners of the Dortmund suburban district have decided to build an electric railroad at the district's expense. The General Electric Company (Allgemeine Elektrizitätsgesellschaft), of Berlin, whose bid of 1,640,000 marks ($390,320) has been accepted, will build the road and operate the same, under a concession, for a period of ten years. New electric roads are being built in many European cities by this company.

JOHN-MANVILLE COMPANY.—The British Johns-Manville Company, Limited, has been formed in London for the purpose of undertaking the selling agency for the specialties of the H. W. Johns-Manville Company, 100 William Street, New York. The capital of the company is $25,000. The directors will be Edward Bergtheil, of the London firm of Bergtheil & Young; H. J. Joseph, who will also be the manager of the company, and G. W. Becker, formerly of the New York offices.

HOBART ELECTRIC MANUFACTURING COMPANY.—An announcement has been received of the reorganization of the Hobart Electric Manufacturing Company, of Troy, Ohio, which went into effect on January 1. The purpose of this change is to materially increase the capacity of its factory. The capital stock of the company has been increased and contracts are now being entered into for a large and modern addition to its already well-equipped factory, which will enable it to treble its output. The secretary and treasurer, who held a controlling interest in the old company, will retain their holdings in the new organization and will be actively engaged in its management. Mr. C. C. Hobart, who has been so long identified with this company, retires from an active interest in the reorganized company. The Hobart Electric Manufacturing Company, although it has made little effort to force itself on the notice of the public, has, nevertheless, more than quadrupled its business within the last few years. A very large proportion of its output of dynamos and motors has been disposed of to concerns who are constant users of electrical machinery, and who, having found the Hobart apparatus to be thoroughly efficient and satisfactory, have favored it with continued patronage. In a quiet way the Hobart Electric Manufacturing Company has increased its business to such an extent that even with its constantly increasing facilities it has been unable to keep up with its orders. A number of contracts of from $10,000 to $25,000 each have been secured within the last year, so that the problem of selling has not caused much anxiety as compared with the problem of deliveries. Starting a number of years ago with the manufacture of a low-priced dynamo and motor, the Hobart Company has now come to be recognized as manufacturers of a standard machine. Especial attention has been paid by it to those parts of a machine which most frequently cause annoyance in operation. Aside from a standard line of dynamos and motors, this company also manufactures a dynamo designed especially for use with gas and gasoline engines. This machine adds to a standard machine a heavy fly-wheel and a third bearing to support it. It is a successful dynamo for overcoming the flicker in the lights caused by the irregular impulses of gas engines. A direct-connected electric coffee mill for use in groceries manufactured by this company has also met with popular favor.

A NEW TELEPHONE MANUFACTURING COMPANY.—The Dean Electric Company has been incorporated under the laws of the State of Ohio by Samuel B. Rawson, I. H. Griswold, T. M. Brush, A. E. Barker and W. W. Dean, to engage in the telephone manufacturing business at Elyria, Ohio, at which point a modern factory building will be erected on the main line of the Lake Shore Railroad. The names of several of the incorporators will be recognized as those of prime movers in the independent telephone field. Messrs. Rawson, Griswold and Brush are the founders and builders of a large number of exchanges in the States of New York and Ohio, among which are Albany, Schenectady, Cohoes, Niagara Falls, Elyria, Ohio, and numerous others. Mr. A. E. Barker has been connected with the engineering staff of the Kellogg Switchboard & Supply Company, of Chicago, having built the Detroit and New Orleans exchanges. He has also had charge of the sales end of the Kellogg Switchboard & Supply Company, with the title of sales manager. Mr. Dean has been connected with the telephone business for about 22 years and has been with the following companies: The Bell Telephone Company, of Missouri, at St. Louis; the Union Telefonica Company, Buenos Ayres, South America; the American Bell Telephone Company, of Boston; the Western Electric Company, of Chicago, and the Kellogg Switchboard & Supply Company, of the same city. The officers of the new company are as follows: Samuel B. Rawson, president; William W. Dean, vice-president and chief engineer; T. M. Brush, treasurer; A. E. Barker, secretary and general manager.

FIRE AT 131 LIBERTY STREET, NEW YORK.—Fire broke out about 3 A.M., January 5, at 131 Liberty Street, in which building a number of electrical concerns are located. The flames started on the sixth or top floor, in the printing plant of Boschen & Wefer. The entire floor is completely gutted and the roof burned off. The amount of water which was used to quench the fire must have been enormous, as practically all the ceilings on the floors below leaked very badly when seen by a representative of the ELECTRCIAL WORLD AND ENGINEER. On the fourth floor J. P. Hall, the electrical engineer and contractor, has his offices. It was said that the damage done there would amount to about $1,500. The D. H. Darrin Company, manufacturers of elevators, etc., has its factory on the third floor. About $2,000 worth of damage is estimated to have been done. On the second floor the Automatic Switch Company has its plant. About $2,000 worth of damage is estimated to have occurred. The D. H. Darrin Company has its offices on the first floor. About $1,000 is expected to cover the damage. On the ground floor B. F. Sturtevant & Co.'s store and offices are located. It is believed that $1,000 will cover the damage done there. The fire is reputed to have started by the falling of a live coal out of a stove used by a plumber, who was making some repairs on the top floor. Most of the damage done is covered by insurance.

CHAMBLY POWER HOUSE.—In connection with our recent important and long article on electric light and power at Montreal, in the description of the Chambly power plant, it should have been stated that the McCormick water wheels referred to were built by the S. Morgan Smith Company, of York, Pa. One of our drawings showed two pairs of wheels on a line direct-connected to a generator, the wheels and draft boxes being placed in a concrete flume. This was the way the wheels were set when the plant was originally built. As remodeled, however, the plant has the water wheels and draft boxes on the inside of steel penstocks, the ends of which were shown in another of the cuts. At the time the dam at Chambly "went out" some months ago, the water wheels were placed in steel penstocks because it was feared that the concrete flumes might not stand much longer.

SOME HARRISBURG ENGINE ORDERS.—The engineering and contracting firm of Mackenzie, Quarrier & Ferguson, 114 Liberty Street, New York, has taken an order for a 150-hp Harisburg standard simple engine from the Ironclad Manufacturing Company, of Brooklyn, direct-connected to a 100-kw generator. The equipment will be used for both light and power. A 75-hp Harrisburg simple engine has been ordered for lighting Healy's Restaurant, New York. The generator will be a 50-kw one of Western Electric make. Among foreign orders received within the past few days is one for a 125-hp engine to be belted to a 75-kw General Electric generator for shipment to Chili for lighting use.

MEXICAN LIGHT AND POWER SCHEME.—Mexican advices state that Mr. James Kilton has secured a contract for furnishing electric light and power and the construction of a system of water works at Matehuela, a city of some 15,000 inhabitants, in the State of San Luis Potosi, Mexico. The plans include the building of four electric generating plants, which are to obtain power from water to be piped from large natural springs located on top of a mountain 1,000 ft. above the city and about 22 miles distant. The water of these springs is to be piped to the power stations and thence conveyed to Matchuela for the purpose of supplying the mains of the water works system.

EQUIPMENT FOR MEXICAN MINES.—The Penoles Mining Company, which operates extensive properties at Maprine, Mexico, placed recently contracts for considerable electrical equipment for driving hoists, pumps and compressors and lighting the mines. The contracts called for a 2,500-hp plant. The Allis-Chalmers Company, New York, secured the order for the engines, while the General Electric Company obtained the order for the generators—three-phase, alternating-current type.

LIGHT AND POWER STATION AT DRAMMEN, NORWAY.—A new light and power station has just been opened at Drammen, Norway. This station receives its power from Gravfos Falls over a 23½-mile transmission line. The entire electrical equipment, both for the station at the Falls and the one in the city, was furnished by the Oerlikon Company. The power station at the Falls has a capacity of 5,400 hp, and consists of six 900-hp units. The current is transmitted at a potential of 25,000 volts.

EQUIPMENT FOR LEHIGH CEMENT PLANT.—The Lehigh Portland Cement Company is to extend its plant at Ormrod, Pa. Considerable new equipment has already been contracted for. Mackenzie, Quarrier & Ferguson, 114 Liberty Street, New York, took an order for a 340-hp tandem-compound Harrisburg standard engine, to be direct-connected to a 225-hp General Electric generator. Several motors are also to be installed.

BALL ENGINE ORDERS.—Dilworth, Porter & Co., Limited, Pittsburg, Pa., has recently placed a contract for three direct-connected units, the engines for which are to be furnished by the Ball Engine Company, Erie, Pa. The Sailors' and Soldiers' Home, of Grand Island, Neb., has contracted for a direct-connected unit. The Ball Engine Company, Erie, Pa., will build the engine.

THE DUNKIRK POWER & HEATING COMPANY, of Dunkirk, N. Y., has just completed the installation of the following units in addition to the previous plant: A 225-hp tubular boiler, under which is a Murphy automatic smokeless furnace; a 20 by 42 simple non-condensing Nordberg Corliss engine; a 250-kw. belted Western Electric, moderate speed, generator and switchboard appliances. Exhaust steam is used for steam heating through underground mains.

MEXICAN HYDRAULIC PLANT PROJECTED.—A hydraulic plant is about to be built on the River Tanoco at a place called Chorro Grande, in the State of Vera Cruz, Mexico. Filiberto Romero, of Vera Cruz, is primarily interested in the project. It is proposed to develop current for lighting and power use in the vicinity.

KEYSTONE ELECTRIC COMPANY has recently installed a 450-kw, 220-volt unit for the Erie Electric Light Company, of Erie, Pa. Mr. H. B. Coho is now vice-president and general manager of the Keystone Company, to which he is giving his personal attention.

General News.

THE TELEPHONE.

MEDORA, ILL.—The Medora Telephone Company, has been incorporated with a capital stock of $10,000. The incorporators are John Payne, Oliver Pirwin and William J. Bell.

BLOOMINGTON, ILL.—The Washington City Rural Telephone Company has purchased the Washington Telephone Exchange from Receiver Heald, of the Peoria and Eastern Telephone Company. Paul Goddard is president of the new company.

ALEXANDRIA, IND.—The Central Union Telephone Company will put in a new switchboard and change its system from magneto to the central energy system.

VINCENNES, IND.—The report of the first year for the Knox County Home Telephone Company shows a growth of 1300 connections with lines south, north, east and west. By Jan. 10 the Princeton line will be finished. The Sullivan connection has been in operation two months, and a long distance line will connect Indianapolis in the near future.

NOBLESVILLE, IND.—On Dec. 24, the entire interior of the Home Telephone Company exchange in this city was burned, the result of a cable coming in contact with the trolley wire of the Indianapolis-Northern Traction Company. Over 200 telephones were burned out. Many patrons who answered the false call were shocked and a number were burned.

CORYDON, IND.—The Cumberland Telephone Company is putting forth extraordinary efforts to enlarge its service in Southern Indiana. The company has agents out inducing farmers to build their own lines promising them connection and service under very favorable terms. It is claimed a large number of lines will be built by the farmers under the stimulus of the favorable conditions offered.

INDIANAPOLIS, IND.—The Central Union Telephone Company is arranging to divide the State into four districts, with a district superintendent in each division. The four district headquarters will be at Indanapolis, Logansport, Anderson and Terre Haute. A fifth division headquarters may be established at Ft. Wayne later on. The officials say the work of extending the service is being carried on so rapidly that it is no longer possible to handle it from one central point. Under the new plan the division superintendents will work under the general district superintendent in this city. R. A. Swan has been selected for Anderson, J. H. Sheppler for Terre Haute, and M. D. Atwater for the Indianapolis district.

BOONE, IA.—The headquarters of the Iowa Telephone Company are to be removed from Davenport to Des Moines.

COUNCIL BLUFFS, IA.—Mr. Thomas D. Metcalf and other local parties are endeavoring to revive interest in an independent telephone system, a movement for which was agitated something over a year ago, but failed to succeed because of the strong opposition by the Bell people.

PAXICO, KAN.—The Paxico Telephone Company has been incorporated with a capital stock of $2100.

REPUBLIC CITY, KAN.—The Republic City Telephone Company has been incorporated with a capital stock of $2500.

BELLVILLE, KAN.—The Bellville Independent Telephone Company has been incorporated with a capital stock of $35,000.

MARYSVILLE, KAN.—The Marysville Telephone Company plans to erect a new switchboard of from 300 to 400 drops capacity. The company will build quite a good many party lines during 1904. It has 234 telephones installed, the user of each paying $1 and $2 a year, according to service.

FRANKFORT, KY.—The Kirksville Telephone Company has been incorporated with a capital stock of $7500.

KENSINGTON, MD.—The Kensington Telephone Company is the name of a new concern organized here with B. A. Chapin as president.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company will expend $750,000 in improving its entire system.

BALTIMORE, MD.—The Hughes Telephone Mfg. Company has recently issued bonds to the extent of $50,000 for the purpose of developing the capacity of its plant.

PITTSFIELD, MASS.—The New York Central Railroad is installing a complete system of telephones in the yard in this city and at the Junction, which will connect the switch houses and terminals with the freight depot.

YPSILANTI, MICH.—The Washtenaw Home Telephone Company has been refused a franchise here.

LAKE CITY, MICH.—The Missaukee Telephone Company has been incorporated with a capital stock of $5000.

MENOMINEE, MICH.—The Central Telephone Exchange has just completed the installation of its new system. There are 700 telephones connected and the exchange cost $24,000.

WAYNE, MICH.—The People's Telephone Company at its annual meeting elected the following officers: President, Joseph Waltz; vice-president, John Chamberlain; secretary and treasurer, F. L. Edwards.

KALAMAZOO, MICH.—The Citizens' Telephone Company has perfected its re-organization, with F. P. Rowe, president; R. C. Packard, secretary and general manager; E. W. Bowman, treasurer. W. Wheeler, Chicago, is constructing engineer. The company is capitalized at $250,000, and will erect an extensive independent system in Kalamazoo with branch exchanges in a number of surrounding towns.

GRAND RAPIDS, MICH.—The new Strowger automatic telephone plant of the Citizens' Telephone Company is about completed. All that remains to be done is the completion of the work of cutting in and testing. The company expects to switch to the automatic system before Feb. 1, with about 4500 subscribers. The services of about 100 telephone girls will no longer be required, but the company will retain probably 40 employees in the long distance and information departments.

WASECA, MINN.—The Tri-State Telephone Company intends to build a line from here to Albert Lea.

REDWOOD FALLS, MINN.—The Redwood County Rural Telephone Company is constructing an extension to its line from here to Morton.

LA PLATA, MO.—The La Plata & Western Telephone Company has been incorporated with a capital stock of $1500. Directors: J. A. Dusley and others.

ST. CHARLES, MO.—The Kinloch Telephone Company is constructing a line from this city to Portage des Sioux and West Alton, this county. The line will be in operation by Jan. 15.

HANNIBAL, MO.—Articles of incorporation for the Hannibal and Ralls County Telephone, Company have been filed. The incorporators are J. I. Davidson, Dr. W. L. Birney and I. H. Harper.

GALLATIN, MO.—The Crab Orchard Telephone Company, of Gallatin, has been incorporated; capital stock, $2008, all paid. Incorporators: W. E. Hathaway, Hiram Burns, W. P. Heysey, E. E. Duffy, E. H. Cravens, M. A. Shipley, John O. Heaston, W. T. Roper and others.

LIVINGSTON, MONT.—The Rocky Mountain Bell Telephone Company intends to construct telephone lines up the Yellowstone and Shield River valleys. The lines will be built from Livingston.

BASSETT, NEB.—At a special meeting of the stockholders of the Bassett and Springview Telephone Company the capital stock was increased to $25,000. This increase is to provide for new extensions which are projected in Rock, Brown, Holt and Loup Counties next spring.

ORD, NEB.—The Valley County Telephone Company has made a move to buy out the independent exchanges at Ord and North Loup and reorganize as a mutual company. The business men of both places are encouraging the movement as it will give valuable communications with both Custer and Garfield Counties and make a system which will embrace about 1000 telephones in the home county.

HILLSBOROUGH, N. J.—The Hillsborough & Montgomery Telephone Company, Hillsborough, Somerset County, has been incorporated; capital, $125,000. Incorporators: Peter A. Garretson, William C. Hendrickson, William M. Frankhouser, Louis E. Opie, A. J. Van Nuns, Belle Meade, David J. Smith and Jacob C. Gulick.

MANCHESTER, N. Y.—The Clifton Springs Telephone Company is extending its line north of Gypsum.

NORTH WOLCOTT, N. Y.—The North Wolcott Telephone Company is the name of a new company being formed here by N. J. Field, J. N. Robertson and others.

SHERMAN, N. Y.—The Independent Telephone Clearing Association has been incorporated with a capital stock of $5000. Directors: H. H. Corbett, W. H. Homewood and others.

CHARLOTTE, N. C.—It is reported that a deal is on foot for the purchase of the extensive interests of the South Carolina Long Distance Telephone Company by the Bell Company. This move is said to be a result of the failure of the American Contracting Company which has been financing the South Carolina Long Distance Company. It is understood that the Bell Company will make many improvements on the local system in the city of Columbia where the Long Distance Company has large holdings.

FARGO, N. D.—The Hunter Telephone Company has purchased the private wire from Blanchard to Amenia and will build one to Gradin.

SHELDON, N. D.—The Northwestern telephone line is to be extended from Englevale to Fort Ransom.

MT. VICTORY, OHIO.—The Mt. Victory Telephone Company has been incorporated with a capital stock of $25,000.

NELSONVILLE, OHIO.—The York Telephone Company has been incorporated with a capital of $1000. Directors: W. S. Follett, E. R. White and others.

OTTAWA, OHIO.—The village council has refused a franchise to the Central Union Telephone Company (Bell) which has been endeavoring to get into Ottawa.

MUSCOGEE, I. T.—The North American Telephone Company has completed the Denison-Wagoner division of its line and cut in on the local exchanges here. This company is covering Indian Territory and Oklahoma with its long-distance toll lines and already has connection with 157 exchanges in North Texas, Oklahoma and Indian Territory. The line is being built as rapidly as possible north to Joplin, Mo., where it will make direct communication with Kansas City and St. Louis.

TORONTO, ONT.—The Canadian Telegraph & Telephone Company is about to make application to the civic authorities of Toronto for permission to do business in this city. This company, which will have exchange connection with all the independent telephone companies of the United States and which also has the right to construct long distance lines from the Atlantic to the Pacific, intimates that it is prepared to give service at a rate much lower than that now charged in Toronto.

OTTAWA, ONT.—The city of Ottawa has received another independent telephone offer. This now comes from H. Waddington, president of the Stark Electrical System, of Toronto, a new corporation. The company proposes to give a combined service of telephone, electric light and power over one circuit. Arrangements have just been completed to install a plant in the town of Toronto Junction, Ont., and Ottawa is asked to await the result. The company claims that telephones will be given at 25 per cent of the present cost, and electric light at two-thirds the present cost. The company will make Ottawa an offer for an area within a radius of 15 miles at the following rates: Telephones $6 per annum and one cent for each out-going call, the maximum cost to be $15 per year for house and $36 for business telephones.

ELECTRIC LIGHT AND POWER.

OPELIKA, ALA.—The Alabama Electric Light & Power Company has been incorporated by C. G. Abercrombie and H. C. Davidson, both of Montgomery, to furnish electric lights and power for lighting Opelika and other towns and cities in this state and the state of Georgia. Capital, $50,000.

FLORENCE, COL.—It is stated that another power-house for supplying power to the mines of Cripple Creek and the traction company at Pueblo will be built by the Woods Investment Company on upper Beaver Creek in the vicinity of Pike's Peak.

DENVER, COL.—L. B. Curtis, of Denver, constructing engineer of the Routt County Electric Light & Power Company, writes that plans and specifications for the electric plant are being prepared and bids for construction will be received about April 1. The probable cost of plant will be $60,000.

LITTLETON, COL.—The Canon Power Company has been incorporated with a capital of $500,000 to utilize the waters of Bear Creek for generating electrical power to supply light to Morrison, Golden, Ft. Logan, Littleton, Englewood and parts of Denver. Incorporators: Albert B. Sanford, Arthur K. Smith and Geo. J. Bucher. The plant will be near Littleton.

WASHINGTON, D. C.—The Senate Committee on Pacific Islands and Porto Rico has made a favorable report on the bill to approve a special act of Legislature of Hawaii providing for the manufacture and distribution of electric light and power on the island of Oahu.

COLUMBUS, GA.—The Columbus Power Company has ordered machinery for developing additional water power which will bring the total up to 9000-hp. The new machinery will arrive in about four months time.

SHELBYVILLE, ILL.—The Shelbyville Water, Heat & Light Company has been incorporated with a capital of $50,000. Incorporators: C. S. Scovil, W. H. Beem, W. S. Middlesworth and others.

BLOOMINGTON, ILL.—The Consumers' Heat & Electric Company has purchased a 400-kw, 220-volt direct-connected General Electric generator, and a 600-hp Allis-Chalmers Corliss engine. This new equipment is now being installed in the company's new plant.

JEFFERSONVILLE, IND.—The United Gas & Electric Company has been granted a franchise in this city. The ordinance provides that the city shall pay $60 each a year for 110 or more arc lights for street lighting and settle an old bill of about $6500, on a basis of $46.50 for the lights that have been in service since Oct. 9, 1902.

SOUTH BEND, IND.—Contracts for the water power and electrical machinery for the power plant of the Oliver Chilled Plow Works are reported to have been awarded as follows: Westinghouse Electric & Mfg. Company, of Pittsburg, Pa., three 500-kw alternating current generators, switchboard, etc.; Dodge Mfg. Company, of Mishawaka, harness for 12 water wheels, and to the Jas. Leffel Company, of Springfield, Ohio, water wheels, turbines and governors.

RICHMOND, IND.—The local electric light rate war is not only arousing much interest here, but in other cities of the state. In some cities the local experience is held up as an indication of the troubles that municipal lighting is sure to bring. Mayor Zimmerman and other city officers are firm, however, in their declaration that the private company cannot "oust" the city from the business. The fight between the Light, Heat & Power Company and the municipal plant is sure to be the issue in the next campaign. Councilmen standing for re-election will be forced to stand for or against the sale of the municipal plant. On this issue an appeal has been made to the people. Mayor Zimmerman said: "If the city plant never does better than meet expenses it will have done a great good in bringing the price of electric lighting down to a reasonable basis. We would not have cheap electric lighting to-day but for the city plant, and we will have it no longer if the city is sold out to the private company."

GRAETTINGER, IA.—The citizens are planning to put in a $10,000 electric light plant.

CHARLESTOWN, KY.—A franchise for an electric light plant has been granted to Clarence R. Hay and work will be started at once. The town will take 20 arc lights at $48 per annum on a moonlight scale.

BELFAST, ME.—L. G. Vose, general manager Belfast Gas & Electric Company, writes that it is proposed to construct a complete water power plant at Hiramdale Falls.

IPSWICH, MASS.—Notes for $5000 for a lighting plant will be issued by the treasurer and selectmen.

DULUTH, MINN.—At the coming election a proposition to issue $50,000 water and light extension bonds will be voted on.

WINONA, MISS.—The Winona Water, Sewerage, Ice & Light Company, of Winona, has been incorporated with a capital of $250,000, with Claude R. Kelso, Robt. A. Allison and Arthur Blake, as incorporators.

COLUMBIA, MO.—The City Council has decided to purchase the water and light plant of the Colombia Water & Light Company.

RED LODGE, MONT.—It is reported that the Electric Light Company will install a new plant in the spring.

LITTLETON, N. H.—This town is establishing an electric light plant of its own. The equipment will include two 30-inch turbines which are being supplied by J. & W. Jolly, of Holyoke, Mass.

SODUS, N. Y.—This village is contemplating the erection of a $25,000 electric light plant. Mr. A. B. Williams can give information.

FRANKLIN, OHIO.—The Franklin Electric Light Company is installing a new engine, generator and boiler.

OAK HARBOR, OHIO.—The Oak Harbor Electric Company has been organized by C. H. Graves, Geo. Mylander, S. Mylander and E. B. Graves.

MECHANICSBURG, OHIO.—T. J. Long, of the Mechanicsburg Light & Power Company, writes that it is proposed to construct an electric light plant at a cost of about $8000.

BUCYRUS, OHIO.—The Bucyrus Electric Light Company is erecting a new lighting plant and the equipment has been received. It is expected the plant will be in operation in about 30 days.

TOLEDO, OHIO.—The board of public works has decided to install electrical power on the swing of the Cherry Street bridge and bids will be asked for on the motors and other necessary equipment.

CLEVELAND, OHIO.—Electric lighting companies throughout the State have joined hands in a movement to secure the repeal of the law passed by the last Ohio Legislature relieving the railway companies from maintaining arc lights at railroad crossings.

COLUMBUS, OHIO.—The Indianola Heating & Lighting Company has given a blanket mortgage for $1,000,000 to the Guarantee Title & Trust Company, of Cleveland. The company is erecting a large heating and lighting plant and the mortgage covers all the property.

TOLEDO, OHIO.—The Fisher Electric Company, of Toledo, has received a contract for installing an electric lighting plant at Capac, St. Clair County, Mich. The equipment will include a 150-hp horizontal automatic engine, a single phase, 60 cycle, 2300-volt, 75-kw lighting generator, together with necessary switchboard apparatus. The company commenced business about 14 months ago and has filled a number of contracts of this character.

GETTYSBURG, PA.—Adam Ertter is interested in the construction of an electric light plant.

COALPORT, PA.—The Coalport Light, Heat & Power Company, of Coalport, has been incorporated with a capital of $5000.

STEWARTSTOWN, PA.—The Deer Creek Water & Water Power Company, of Stewartstown, has been incorporated with a capital of $6000.

NORTHUMBERLAND, PA.—The Northumberland Electric Light, Heat & Power Company, of Northumberland, has been incorporated with a capital of $5000.

YANKTON, S. D.—Mr. Edmunds, proprietor of the electric light plant, has offered the City Council to sell his plant, exclusive of tools and office fixtures, for $15,000.

HENRIETTA, TEX.—The City Council has granted a franchise to the Brower Lighting Company to establish an electric light system through the town.

SAN ANTONIO, TEX.—The election to vote on the proposition to issue $200,000 of bonds for the construction of a municipal electric light and power plant was held on Dec. 19 and resulted in overwhelming defeat.

WAXAHACHIE, TEX.—The Waxahachie Gas & Electric Company has been organized here with a capital stock of $100,000 for the purpose of installing an electric light and power plant and a gas plant. The incorporators of the company are J. F. Strickland, Osce Goodwin, W. C. Ross and M. B. Templeton, all of Waxahachie, and R. C. Vickery, of Fort Worth.

SALT LAKE CITY, UTAH.—Some time ago a protest was made by citizens against the alleged inferior service rendered by the Utah Light & Power Company, which resulted in the appointment of a committee to investigate the matter. The committee has submitted its report which states, in substance, that while the service is far from what could be desired, on account of a lack of modern equipment for regulating the electrical current, it was no better than had been represented in the protest. The committee, however, announced that the electric light company had expended during the present year $520,000 in the improvement of its system and that of this amount $170,000 had been spent on the Salt Lake service. The report concludes with the statement that the Utah Light & Power Company is doing everything in its power to remedy the conditions at present prevailing. R. S. Campbell, manager of the lighting company, assured the committee that a large sum would be expended during the present year in improving the system.

COLUMBIA CITY, WASH.—The Town Council has granted a franchise to the Snoqualmie Falls Power Company to install an electric light and power station in Columbia.

WHEELING, W. VA.—The County Commissioners have decided to install an electric light plant at the County Infirmary at East Richmond.

COLEMAN, ALBERTA, CAN.—The International Coal & Coke Company has let contracts for the equipment to be installed in its coke works. The Westinghouse Elec & Mfg. Company will furnish the electrical equipment, and the Phœnix Iron Works, of Meadville, Pa., the engines.

CITY OF MEXICO, MEX.—The Mexican Government has granted a concession to Filiberto Romero for the establishment of an electric power plant on the River Tancoco, at a place called Chorro Grande, in the state of Vera Cruz.

MATEHUALA, MEX.—James Kilton has obtained the contract to supply this city with electric lights and power and to establish and operate a system of water works here. He has already begun the development of extensive plans which include the construction of four electric generating stations which are to obtain their initial power from water which is to be piped from large natural springs situated on the top of a mountain, situated at a height of 1000 feet above this city and 22 miles distant. The water of these springs will be piped to the power stations and thence conveyed to this city and used to supply the mains of the water works system. Engineers have examined and made favorable reports on the project and surveys are now being made preparatory to beginning construction work. It is proposed to not only supply the city with electric lights and power, but to also furnish power for operating the numerous mines which are situated in this district. A telephone system is being established here. W. H. Smith is interested.

OTTAWA, ONT.—A conference has taken place between the Ontario government and those interested in the development of the water power on Kettle Falls, at Fort Frances, Ont., Minneapolis men have already secured the rights on the United States side, and have also a preference on the rights on the Canadian side. The Ontario government insists on the condition that one-half of the power developed, which is about 5000 horse power, shall be used exclusively on the Canadian side. The conference closed without reaching any agreement.

THE ELECTRIC RAILWAY.

COLUMBUS, IND.—The citizens of Wayne Township have voted a 2 per cent subsidy tax for the Indiana Central Interurban Railway, which will extend from Columbus to Seymour. The tax will amount to $25,000.

KOKOMO, IND.—The Kokomo, Marion & Western Traction Company has let the contract for the equipment of a new power station in this city. It is said the machinery will cost $250,000, and that the buildings and power plant complete will cost $400,000. The road is almost completed to Marion.

RICHMOND, IND.—The Wayne County Commissioners have granted a franchise to the Columbus, Greensburg & Richmond Traction Company through the county and to cross the public highways. The company has its own right of way. The franchise provides for the building of the line within two years.

EVANSVILLE, IND.—The officials of the Evansville, Boonville & Rockport Interurban Railway Company have made arrangements with the Interurban Construction Company, of Indianapolis, to finance and construct the road. The engineers of the two companies are drawing plans and specifications, and when completed, contracts will be signed. Charles E. Maley, Claude Maley, Daniel Wertz and William Threlkeld, of Evansville, are the principal members of the company.

INDIANAPOLIS, IND.—The recent order of the Board of Public Works requiring the interurban cars entering this city to stop at street crossings wherever signaled and take on and let off city passengers has aroused a storm of objection by the interurban managers. They insist that it is an imposition on the interurban passengers to be crowded by city passengers, and that it is a great waste of time. President Henry, of the Indianapolis & Cincinnati Interurban line, suggested that the Board has full power under its contract with the City Street Car Company to compel the latter to give all the service that the demands of the city traffic require. Mr. Henry thinks there should be no necessity for using interurban cars in city service. The Board, however, renewed its order and threatens to punish the companies found guilty of refusing to take on city passengers.

LEWISTON, ME.—Fire, a few days ago, destroyed the car house and 35 cars of the Lewiston, Brunswick & Bath Street Railway, involving a loss of about $50,000.

AMHERST, MASS.—The Amherst & Sunderland Street Railway Company has petitioned the Railroad Commissioners for authority to issue bonds to the amount of $117,000 for the purpose of retiring outstanding bonds to the amount of $51,500 of funding so much of the company's floating indebtedness as may have been incurred for construction and equipment, and for the purchase of additional real and personal estate.

TRAVERSE CITY, MICH.—The Traverse City & Peninsula Railway Company has been organized at Traverse City, with a capital stock of $500,000, for the purpose of building an electric railway from Traverse City to Old Mission and the intervening summer resort and fruit growing country. The officers of the company are L. K. Gibbs, president; W. P. Crotser, of Traverse City, secretary; J. O. Crotser, of Kingsley, treasurer.

SPRINGFIELD, OHIO.—The Springfield & Washington C. H. Traction Company has been granted an extension of time to Jan. 1, 1905, in which to construct its line. The promoters claim they have succeeded in financing the project, and that work will be started within a few weeks.

MANSFIELD, OHIO.—The promoters of the Mansfield & Wooster Traction Company assert that arrangements have been completed for financing the project, and that work of construction will start in the spring. The headquarters of the company are in Shreve.

CLEVELAND, OHIO.—The Lake Shore Electric Railway Company has just placed contracts with the C. & G. Cooper Company, Mt. Vernon, Ohio, for a 1200-hp cross-compound condensing engine, and with the General Electric Company for a 1500-kw alternating-current generator, together with switchboards and equipment for two sub-stations.

FINDLAY, OHIO.—The Buckeye Traction Company has been organized by local people to build an electric railway between Toledo and Columbus by way of Fostoria, Carey, Upper Sandusky and Marion. A line from Fostoria to Marion would complete through connection, as roads are already in operation from Toledo to Fostoria, and from Marion to Columbus. The capital stock of the new company will be $1,000,000.

CHARDON, OHIO.—W. C. Warner, Monroe Warner and Andrew Warner, of Chardon, are the chief promoters of the proposed Cleveland, Chardon & Meadville Railroad Company, which has been incorporated to build an electric railway from Chardon to Meadville, Pa. The road will touch a number of towns that at present are isolated. A private right of way has been secured over a greater portion of the route.

SALEM, OHIO.—The Stark Electric Railway Company, which is completing its line into Salem, is negotiating for the purchase of the property of the Salem Electric Railway Company. The city system includes a power house and about 4 miles of road commanding the most desirable entrance to the town. The Salem people, it is said, ask $100,000 for the property, which is considered too high by the prospective purchasers.

COLUMBUS, OHIO.—Samuel W. Bennett, special counsel to the State Attorney-General, has rendered the opinion that stockholders of railroads, street railroads, electric light, gas, waterworks and other so-called quasi-public corporations are not exempt from double liability on their stock for the debts of these corporations by the recent constitutional amendment. It is claimed that the amendment applies only to private corporations. A number of such corporations have recently taken out charters in Ohio, under the impression that only a single liability could be enforced in the future under the amendment.

UNIONTOWN, PA.—The building of an electric railway from Fairchance to Point Marion, a distance of 13 miles, has been decided upon by a company including O. W. Kennedy, general manager of the H. C. Frick Coke Company, of Uniontown; John W. Byers, Lee B. and Owen H. Brownfield and others. A charter will be applied for, and the company will probably be capitalized at $250,000.

ERIE, PA.—At the second annual meeting of the stockholders of the Erie, Cambridge, Union & Corry Railway Company, the following officers were elected: P. A. Gibson, of Erie, president; John Doll, of Erie, secretary; F. L. Hoskins, of Edinboro, treasurer. Arrangements were made for active construction work to commence in the early spring. All contracts have been let for material and equipment. The capital of the company is $1,000,000. Axel H. Engstrom, of Philadelphia, is consulting engineer.

HARRISBURG, PA.—Application will be made at the State Department Dec. 31 for a charter for the West Penn Railway Company, which will be a merger of the electric lighting and power plants in the coke regions and the Pittsburg, McKeesport & Connellsville Electric Railway Company. The incorporators will be William S. Kuhn, Jacob V. Van Wagener, John I. Cockburn, Jesse H. Purdy and Jerome Hill, Jr. The capital stock will be merely nominal until the merger is completed, when it will be increased to more than $5,000,000. The West Penn Railway & Lighting Company has been in control of the electric lighting and power plants in Westmoreland and Fayette Counties. The lighting companies that will be included in the merger are located at Connellsville, Dawson, Irwin, Jeannette, Manor, Greensburg, Mt. Pleasant, Tars, New Haven, Uniontown, Fairchance and Masontown. In a number of cases the old stations have been abandoned, power now being supplied to the towns from the new power house, which is located a short distance above New Haven on the Youghiogheny River. Those interested in the company include: W. S. Kuhn, who is the general manager; J. S. Kuhn, E. C. Converse, M. K. Salsbury, W. S. Graham and J. B. Van Wagener. It is probable that W. S. Kuhn will be at the head of the new company. The organization will be completed by placing the lighting and power companies in one company and the railways in another, with the West Penn Railways Company as the holding concern.

WESTERLY, R. I.—The Westerly & Hopkinton Street Railway Company has purchased the control of the Pawtucket Valley Street Railway Company and has elected the following officers: William Hoxsey, president; Frank P. Sheldon, vice-president; J. O. Sweet, secretary and treasurer. The Westerly Gas & Electric Company (common stock is $50,000; preferred, $7500) is under contract of purchase, and will be acquired in a short time. In January the several properties are to be consolidated under the laws of Rhode Island as the Westerly Railway & Lighting Company. Capitalization, $200,000 common stock, $200,000 5 per cent cumulative preferred stock and $400,000 of 5 per cent thirty-year bonds. The management expects to extend the road from Westerly to Hopkinton in the spring.

JACKSON CITY, TENN.—The Johnson City Traction Company has completed its line to New Street, and is now running cars down Watauga Avenue. It now has about 2½ miles of track, and is expecting in the near future to extend the track to the Carnegie Hotel.

NASHVILLE, TENN.—The Silver Interurban Railway Company has just been incorporated here, with a capital stock of $250,000, which will later be increased to $1,500,000. The company will build an electric railway from Nashville to Lewisburg, and will probably extend the line to Huntsville, Ala.

BROWNSVILLE, TENN.—The Shelby County Traction Company will build an electric railway in the near future from Brownsville to Dyersburg, a distance of about 32 miles. The road will be used for both freight and passengers. This company also proposes to construct lines from Memphis to Colliersville and to Bolivar, Tenn. Judge T. J. Latham, of Memphis, is among those interested.

HOUSTON, TEX.—The City Council has passed the ordinance granting a franchise to the Houston & Galveston Interurban Railway Company. The line will be 48 miles in length, the shortest rail route between Houston and Galveston.

PORT ARTHUR, TEX.—The company which has been organized here through the efforts of John W. Gates for the construction and operation of an electric railway from this place to Taylor's Bayou will soon file its charter for record in the secretary of state's office at Austin. It is stated that Mr. Gates owns a controlling interest in the company. It is reported that the Beaumont & Sour Lake Construction Company will be awarded the contract for building the new line.

GALVESTON, TEX.—The Galveston City Railway Company will expend about $60,000 during the coming year for improvements. The original budget for the coming year embraced the proposed expenditure of $227,000 for extensions and improvements, but this sum has been cut down on account of the large amount that will be incurred in street paving due to the raising the grade of the city. Major R. B. Baer, president and general manager of the company, says that the company has expended the sum of $1,068,000 in rehabilitating the system and in improvements since the great storm which swept over the city three years ago.

FOND DU LAC, WIS.—The Fond du Lac & Eastern Railway Company seeks a franchise to build a line in this city and to sell power and light, and to build a power house.

WATERTOWN, WIS.—The Oconomowoc-Watertown Heat, Light & Power Company is seeking a franchise for an electric interurban line to run from Oconomowoc to Watertown, Lake Mills, Jefferson and probably Janesville.

TORONTO, ONT.—The Toronto Railway Company expects to have its new storage-battery plant in operation in three months. This battery is being installed solely to supply power to run the additional service given between 5 and 6.30 in the evening, and in the morning, if necessary. The company has had to increase its services in the morning and evening during the past year on account of the big increase in the suburban population of the city. Many people who removed to the Beaches to spend the summer are wintering there, and an increased number of those employed in the city are residing in East Toronto, Mimico, Eglinton and Toronto Junction.

NEW INDUSTRIAL COMPANIES.

THE MUTUAL STOCK & TELEGRAPH COMPANY, Buffalo, N. Y.; capital, $100,000. Directors: D. F. Harrington, William Walker and Peter S. Wering, Buffalo.

THE INTERMITTENT CURRENT CLEANING COMPANY, New York; capital, $100,000. Directors: G. G. Power, W. H. Donnally, and Frank Hendrick, New York.

THE VEHICLE SPECIALTY COMPANY, of Jersey City, has been incorporated; capital, $50,000. Incorporators: Le Roy S. Louis, William D. Johnston and Louis G. Morton.

THE VESUVIUS BATTERY COMPANY, New York, to manufacture electric batteries; capital, $10,000. Directors: S. G. Whiton, A. S. Apgar and L. H. Bigelow, New York.

BAKER & COMPANY, Newark, N. J., to refine ores, platinum and other materials; capital, $430,000. Incorporators: Cyrus O. Baker, Charles W. Baker, Henry R. Bond, Jr., and Edward A. Colby.

THE ELECTRIC UTILITIES COMPANY, of Mineola, Nassau County, N. Y., has been incorporated with a capital of $1,000,000. The directors are Andrew R. McLaren, Alfred H. Townely, George T. Van Valkenburgh, John D. Mason and Thomas J. Snee, of New York City.

THE DEAN ELECTRIC COMPANY has been incorporated under the laws of the State of Ohio and will erect a modern factory at Elyria, Ohio. The capital stock is $300,000. Incorporators: Samuel B. Rawson, I. H. Griswold, T. M. Brush, A. E. Barker and W. W. Dean.

THE KIRKLAND ELECTRIC COMPANY, of Kirkland, Oneida County, N. Y., has been incorporated; capital, $100,000. Directors: J. F. Wood, Clinton; G. L. Wood and H. B. Sweet, Utica. The directors have organized as follows: President, Henry W. Roberts, of Clinton; vice-president, George L. Wood, of Utica; secretary, James F. Wood, of Clinton; treasurer, Herbert Allen, of Clinton. Horace P. Sweet, of Utica, has been engaged as engineer.

OBITUARY.

CAPT. EDWARD B. IVES, Signal Corps, who had been on duty in the office of the Chief Signal Officer at the War Department for some time past, died in Washington on Dec. 29 from a complication of diseases. He was born in the District of Columbia, but was appointed to the Military Academy from New York in July, 1874.

MR. R. C. VILAS.—Royal Cooper Vilas, president of the Pyle National Electric Headlight Company, died last week in Chicago, aged 61 years. Mr. Vilas was born in Ogdensburg, N. Y. He was at one time General Freight Traffic Manager of the Erie Railroad in New York, and president of the New York Air Brake Company, of New York City.

H. T. RICHARDS.—It is with deep regret that we announce the death of Herbert T. Richards, secretary of the Safety Insulated Wire & Cable Company, which occurred on Dec. 26, last. Deceased was about 42 years of age, and was well known in electrical circles. His death was due to a surgical operation involving the kidneys, from the shock of which he did not rally.

PERSONAL.

MR. JOHN MATHER, of Wayne, Pa., has become general manager of the Merion & Radnor, Pa., Gas & Electric Company, as successor to Mr. W. E. Barrett.

MR. JOSEPH V. KUNZE, manager of the New York offices, 143 Liberty Street, of the Pelton Water Wheel Company, has returned from a trip to Mexico.

MR. MORRIS MEAD, well known for many years past as the city electrician of Pittsburgh, Pa., has retired and will hereafter enjoy his *otium cum dig.* with a pension.

MR. R. H. MANSON has been placed for the time being in charge of the sales department of the Kellogg Switchboard & Supply Company in place of Mr. A. E. Barker, resigned.

MR. ERICH BROCKHAUS, chief engineer of the Siemens-Halske Company, of Berlin, is on a visit to this country, like so many other prominent officers of the company before him.

MR. E. A. CHAPEL, formerly of the electrical department of the Chelsea, Mass., Gas Light Company, has been appointed superintendent of the Nantucket, Mass., Gas & Electric Company.

MR. THOMAS HANKEN has become president of the United Gas & Electric Company, of Dover, N. H., in place of Mr. H. L. Shepard. Mr. G. W. Welch has been elected treasurer.

MR. W. F. HOWE.—The ELECTRICAL WORLD & ENGINEER has a communication from this gentleman, but before using it would like to be furnished by him with some data of identification.

MR. C. E. REYNOLDS, superintendent of the mechanical department of the Rochester Gas & Electric Company, has resigned after 18 years' service to go to Boston. His associates gave him a diamond pin on leaving, as a mark of appreciation.

MR. JOHN F. SKIRROW, an able young man and one of the contributors to this journal, has been promoted to the position of assistant electrical engineer of the Postal Telegraph Cable Company. He was born in England in 1869 and has been with the Postal since 1890.

MR. ARTHUR J. HERSCHMANN, M. E., who has been associated with the Adams Express Company for five years past in New York City, has taken an office at 45 Broadway, and will make a specialty of heating, lighting and ventilating plants, their installation and supervision.

PROF GUIDO GRASSI, of the Turin, Italy, Museo Industrialo, will make a visit to this country next fall to be in attendance at the International Electrical Congress at St. Louis. Prof. Grassi conducts at the Turin Museo the course in electrical science developed by the late Professor Ferraris.

MR. EDWARD W. PARKER has issued for the U. S. Geological Survey a report on the production of gas, coke, tar and ammonia at gas works in 1902, in this country. The figures of 533 companies making gas from coal in 44 states and territories are included in this valuable document.

MR. P. G. GOSSLER, electrical engineer, etc., of the Montreal Light, Heat & Power Company, has resigned his important and responsible position there in order to become associated with the well-known engineering firm of J. G. White & Company, to which he will prove a valuable acquisition.

MR. W. G. ROSS, of Montreal, has resigned as second vice-president of the Montreal Light, Heat & Power Company, and has become managing director of the Montreal Street Railway. Mr. Rodolphe Forget, who resigned from the first vice-presidency of the power company to make way for Mr. McLea Walbank, was appointed to succeed Mr. Ross.

MR. J. T. OAKLEY, a well known leader in Democratic politics, has been appointed under the Tammany regime as Commissioner of the Department of Gas, Water and Electricity of Greater New York, succeeding Col. R. Munroe, who is also a member of the Democratic party, but conducted his department on very independent lines under Mayor Low.

MR. WILLIAM MACKENZIE, of Toronto, Can., who is president of the Saô Paulo Tramway, Light & Power Company, Limited, is now on a visit to New York. The company operates an extensive system in Saô Paulo, Brazil, which is about to be considerably extended. Mr. Mackenzie is at the Waldorf-Astoria and at the Saô Paulo offices, 29 Broadway.

M. CURIE has declined the red ribbon of the Legion of Honor and gives his reasons. "I don't like decorations," he says. "The institution is bad. Many people whom I esteem have them, but I don't want any. I am of the opinion that the hope of receiving decorations is not necessary as an incitement to acts of devotion or courage, as is commonly supposed."

MR. GEORGE W. EDGE, recently with Stanley & Patterson, has taken a position with the Trumbull Electric Mfg. Company, of Plainville, Conn., and will represent it through the middle west and eastern states. Mr. Edge will call on his old friends in his new capacity. Mr. Frank Trumbull has also accepted a position with the Trumbull Company and will travel in the states west of the Mississippi River and in the southern states.

MR. JOSPER F. KELLER, now manager of the New England Telephone & Telegraph Company will become second vice-president of that company this year. Francis A. Houston, now general counsel, will succeed Mr. Keller as general manager. Matt. B. Jones, of Powers, Hall & Jones, will succeed Mr. Houston as general counsel. Mr. Jones will hereafter give his whole attention to the New England Telephone & Telegraph Company.

MR. P. N. NUNN, chief engineer of the Telluride Company, Colorado, is referred to in the following dispatch from Salt Lake City of January 1: Announcement was made to-day that a new and unique school of electrical engineering would be founded during the current year by Mr. Nunn, of Telluride, Col. It is the intention of the founder to give a full course in mechanical and electrical engineering at Provo Canon, Utah, keeping the students actually employed and under pay during the period of their course.

PROF. S. P. THOMPSON, F. R. S., has just issued, in admirable pamphlet form, his admirable "note" on Gilbert, prepared for the three hundredth anniversary of the death of Dr. Gilbert, December 10, in connection with which event the British Institution of Electrical Engineers has just presented to the corporation of Colchester, where he was born and where he is buried, an interesting picture of Mr. A. Acland Hunt. The painting measures 6 by 4 feet and represents Gilbert expounding his magnetic discoveries and ideas to Queen Elizabeth.

MR. W. S. MONTGOMERY, who has for the past five years been connected with the Conover Condenser Manufacturing Company, of Jersey City, as secretary and sales manager, has severed his connection with that company to assume the management of the Payne Engineering Company of New York City, selling agent of the Payne Company, of Elmira, N. Y., builder of simple and compound automatic engines. On the same date, the Payne Engineering Company will remove to new offices in the Havemeyer Building, No. 26 Cortlandt St., New York.

MR. J. H. ROBINSON, of the U. S. Military Telegraph Corps, who made application as such for membership in the Society of the Army of the Cumberland has been advised by Gen. H. V. Boynton, president of the organization that the executive committee of that body is unanimously in favor of recognizing the claims of members of the Corps who served with the army, to be admitted to membership in the society. Every one must feel that this decision is right, and that the gallant telegraphers who went under fire just as freely as the rank and file are entitled justly to all the honors that can come to them.

MR. CHARLES JOHNS, JR.—A St. Thomas, Ont., newspaper says: "The first year's working of the Street Railway as a municipal service has resulted in a practical balancing of accounts which, in view of the fact that the system has been transformed into an up-to-date one, is considerable satisfactory. The total number of passengers carried was 359,190 and the total received for fares was $13,934.52, showing the average fare to have been 3.977 cents. The actual receipts were $14,603.35, only $136.43 less than the expenditure." It is interesting to learn that a student of the International Correspondence Schools, Scranton, Pa., Mr. Charles Johns, Jr., is manager of the St. Thomas Street Railway. He enrolled with the I. C. S. in June, 1899, at the age of 23, while employed as a machinist.

LEGAL.

MUNICIPAL PLANTS IN NORTH CAROLINA.—The Supreme Court of North Carolina has just handed down an opinion of importance to the effect that for a city to buy or establish a plant for light or water is a necessary expense and therefore does not require a vote of the people.

DUTY ON SUBMARINE CABLE.—Judge Henderson M. Somerville, of the Board of United States General Appraisers, administered a criticism to the Commercial Pacific Cable Company in overruling its claim for free entry for the cable from Hawaii to the United States, which was brought to Honolulu from England. The claim was made on the ground that the laying of the cable was a work of great public benefit. Such a claim, Judge Somerville said, might with propriety be made to Congress, but not to a judicial tribunal, which has no duty but to interpret the law as it finds it.

WATER POWER EMINENT DOMAIN.—A corporation authorized to develop and use the water power of a river and generate electric or other power, light, or heat, and utilize, transmit and distribute it for its own use or the use of other individuals or corporations, is held, in the case of Fallsburg Power & Manufacturing Company vs. Alexander, (61 Lawyers' Reports Annotated 129.) to be for a private use and not a public purpose, and therefore not entitled to exercise the right of eminent domain. Under statutory authority to exercise the right of eminent domain to secure land for a park, it is held, in the case of Laird vs. Pittsburg, (61 Lawyers' Reports Annotated 332,) that land needed for an addition to a free library building located in a public park may be taken.

GUTMANN RECORDING WATTMETER.—The order restraining the Electric Appliance Company, of Chicago, from selling or manufacturing the Gutmann recording wattmeter, which was granted on exparte application of the Westinghouse Electric & Mfg. Company, was continued on Dec. 29 by Judge Kohlsaat, of the United States Circuit Court, after a hearing. The action is based upon a suit brought in Philadelphia, in which the Sangamo Electric Company, of Springfield, Ill., the manufacturer of the Gutmann meter, intervened and became the defendants. In that action it was decided that the Gutmann meter was an infringement of the Tesla patents on the rotating magnetic field of the split phase type which belong to the Westinghouse Company. After an injunction was issued, it was discovered that the Sangamo Company was making a meter in which a slotted disc was substituted for the slotted cylinder before used. The Sangamo Company asked to have the injunction suspended as to this form, but this was refused. An application was made to have the Sangamo Company declared in contempt, but it was shown that at that time its factory was closed and no meters were being made. The contempt proceedings have not been decided. Later it was found that a large number of the disc meters had been sent to the Electric Appliance Company, of Chicago, which was selling them in the due course of business. The restraining order which has now been continued was then applied for.

EVANSVILLE WINS SUIT AGAINST THE CUMBERLAND.—Judge Anderson, of the United States Court, has dissolved the restraining order in the injunction suit brought by the Cumberland Telephone Company against the City of Evansville, Ind., to prevent the removal of its poles and wires from the streets. The court held that the city has a right to order the removal of poles, wires and other property of the company from the streets, and that the Cumberland has no right to operate in the city. It was shown that the Evansville Telephone Exchange was granted a franchise by the city in December, 1882. In July of the following year its business and property were purchased by the Cumberland Company and the latter company has carried on the business since that time. The telephone company alleged and declared that the right to the streets and alleys of the city, granted by the council in 1882 to the Evansville Telephone Exchange became the property of the Cumberland, together with all other property when the transfer was made. The answer of the city of Evansville was that it was outside the powers granted the original company to sell the property and business unless the franchise and ordinance under which it is operating specifically provides for such a sale and transfer. The court adopted this view and held that the Cumberland Company had no rights by the assignment of the Evansville Telephone Exchange and no rights under the ordinance of 1882 which it can ask the court to protect. The injunction was therefore dismissed for want of equity.

EXTRAORDINARY WASTE OF GAS.—The Kentucky Court of Appeals has reversed the judgment of the Meade Circuit Court in the case of the Calor Oil & Gas Company against W. C. McGehee, and affirmed it in the case of the Louisville Gas Company against the Kentucky Heating Company. The cases grew out of the efforts of the Louisville Gas Company to destroy the Meade County natural gas fields, from which the Kentucky Heating Company has for years been securing the gas which it furnishes to customers of Louisville. The Louisville Gas Company officers organized the Calor Oil & Gas Company, the stockholders being A. Hite Barrett, Rudolph Sneed and J. W. Speed. This company took over a number of leases of land made in the county. In this territory they erected what they called a lampblack factory. This factory was constructed with a stockade about it, inside of which no one was allowed to enter, and firearms were discharged to keep the neighbors away. When they began operations the Kentucky Heating Company had a gas pressure of sixty pounds, and in five months this was reduced to thirty pounds. The force of the lamp-black factory was two men, one for day and another for night. In five months the factory produced 300 pounds of lampblack, worth 4 cents a pound, and had consumed about 90,000,000 feet of the natural gas. The lampblack was never shipped away from the factory. On these facts the chancellor enjoined the operation of the lampblack factory, as violating the statutory laws against the wasting of natural gas. The retail price of natural gas for fuel in Louisville is 65 cents per thousand feet, making the value of the gas alleged to have been consumed in making $12 worth of lampblack $63,500.

Trade Notes.

PASS & SEYMOUR, Solvay, N. Y., have just placed on the market a new moulding receptacle. They are made in two styles to use with or without a shade holder. A postal card will bring samples and prices.

PITTSBURGH TRANSFORMER COMPANY, of Pittsburgh, Pa., issued a pretty Christmas folder with cuts of its large transformers and transformer tanks, giving an excellent idea of their solid and substantial construction.

"REASON WHY" is the title of a little folder, illustrated, sent out by the Pass & Seymour Company, Solvay, N. Y., giving reasons why its brass shell lamp sockets are held to be the best. The points are clearly and tersely made.

ROYAL ELECTRIC COMPANY, Peoria, Ill., has issued a neat calendar for 1904 showing one of its 100-kw 60 cycle Royal alternators of the inductor type, with exciter. A little information is given as to the features of the machine.

THE ORGAN POWER COMPANY, Hartford, Conn., has been developing some new devices for organ blowing with an alternating current motor and has issued a little brochure as to its Spencer organ blowing apparatus in general, water and electric.

JOSEPH T. RYERSON & SON, Milwaukee Avenue, Chicago, have just issued the sixth edition of Ryerson's Technical Library No. 4, describing the Continental boiler with Morison corrugated furnaces, and giving useful data and information regarding boiler design and construction.

"THE WHITE BULLETIN," copies of which have reached us, is a house journal issued by the White Sewing Machine Company, Cleveland, Ohio, in regard to its White steam automobiles which have made such a creditable record in the art. The little paper is quite up to the standard of the autos. and makes good reading.

YALE & TOWNE MFG. COMPANY has issued a neat little folder in regard to its chain blocks, this being the most recent printed matter given out by it in regard to the subject. It is called "Three Labor Savers" and deals with its triplex, duplex and differential blocks. Data are furnished as to each of these devices so economical of effort and expense. Copies can be obtained at 9-11-13 Murray Street, New York City.

KELLOGG.—The Kellogg Switchboard & Supply Company, of Chicago, has sent out a handsome new bulletin descriptive of its magneto or generator call telephones. This bulletin is the first of a series which will cover the entire product of the company in the telephone field. The arrangement of the matter and the descriptions and circuits have been carried out so as to constitute a popular text book for the small customer.

INCANDESCENT LAMP WALL CIRCULAR.—The General Electric Company has just issued from its lamp works at Harrison, N. J., a broad-sheet circular on heavy paper, devoted to its Edison lamps, on which is shown, full size, some 37 varieties with the data relative to each. This is a most striking and interesting circular and for the man who has the wall space a very nice thing to post up where it can be looked at every day with admiring eyes. It is very interesting to have thus brought to notice at one glance all the various makes and styles for different purposes, the lamps ranging from the largest to the smallest.

ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has, as already announced in these columns, taken up the manufacture in this country of the Nurnberg gas engine. It is a four-cycle double-acting machine, for all power purposes, and is built in units of from 130 to 6000-hp. It operates with natural, producer, coke oven, blast furnace or illuminating gas. It has been brought to a state of perfection in which it will answer with absolute reliability the most exacting demands of power generation, and in the hands of such a standard concern will doubtless find a very large application in this country.

ELECTRIC APPLIANCE FUSES.—The latest thing in fuses is illustrated and described on page 241 in Electric Appliance Company's catalogue No. 20. The cartridge fuse is made in any capacity from 3 amperes to 30 amperes, and is listed in 125 and 250 volts. The company is now prepared to fill orders in the same capacity for 500 volt fuses. This McBride enclosed fuse is a regular cartridge with the fuse enclosed, and from each end of the cartridge is a soft copper wire which adapts the fuse for any style fuse connection on any cut-out, switch, panel-board, switchboard; or, in other words, it can be used wherever a fuse is desired, with absolute assurance that it will blow without an arc. They require no special cut-out, but fit the old style Sawyer-Mann cut-outs, Edison blocks and any switch connection.

MOISTURE FOR CIGARS.—In the manufacture of cigars the condition of the atmosphere within the building is of vital importance. The air must be kept moist and at a constant warm temperature both in the winter and summer season. For maintaining an even, moist and warm temperature the fan system is peculiarly adaptable, because the quantity and quality of the air is under absolute control and may be varied at will. Fresh air is drawn from outside the building by means of a fan, is circulated through a moistening chamber and, in the winter season, between coils of steam pipes enclosed in a fireproof steel plate jacket, and delivered under pressure to the work rooms, through distributing ducts. The speed of the fan regulates the quantity of the air, the amount of steam varies its temperature and it is evident that the amount of water sprayed through the moistening chamber varies its moisture. The fan is driven by a direct connected engine whose exhaust steam may be used in the heating pipes, or in the summer time when heating is unnecessary it may be by-passed and utilized for other purposes. It is readily seen that with this system the expense of operating is very low as no heat is wasted. The three factories of the American Cigar Company at Tampa, Fla., are provided with the fan system for heating, ventilating and moistening, and the results reflect credit upon the B. F. Sturtevant Company, of Boston, Mass., whose apparatus and system were used.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED DECEMBER 29, 1903.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

747,949. SIGNALING SYSTEM; William H. Dammond, Detroit, Mich. App. filed Nov. 5, 1902. Details.

747,967. TRAIN CONTROLLING AND SIGNALING SYSTEM; Fred P. Green, East Aurora, N. Y. App. filed Feb. 11, 1903. Mechanism by which the air brakes of a train can be operated from the train despatchers office, in case the train runs into a obstructed block.

747,968. ELECTRIC METER; Ludwig Gutmann, Peoria, Ill. App. filed Jan. 6, 1902. Improvements in the construction of a motor-meter in which the motor element has an armature consisting of a disk rotating in a conducting fluid through which current is conveyed to and from the armature, combined with a proper energizing field magnet.

748,053. BAR FOR COLLECTING ELECTRICITY FOR SECTIONAL CIRCUITS; Henry Dolter, Paris, France. App. filed Feb. 19, 1902. A contact shoe, parts of which are magnetic while other parts are non-magnetic, the collector being adapted to engage with studs in the roadbed and by the attraction of its magnetic parts close a circuit through the stud while by the non-attraction of other parrts, the circuit is opened before the contact is actually broken.

748,086. ELECTRIC FIRING GEAR FOR BREACH LOADING GUNS; John F. Meigs, Sigard A. S. Hammar and Leighton N. D. Mixsell, Bethlehem, Pa. App. filed Aug. 27, 1902. An apparatus whereby the contacts for firing the charge can be closed only when the other elements of the device are in proper position.

748,098. SYSTEM FOR CONTROLLING FLUID PRESSURE; Edward D. Priest, Schenectady, N. Y. App. filed May 21, 1903. The air pump on a train is cut out by the controller while the train is stationary, thus avoiding the annoyance to passengers of the operation of a pump, while the train is standing.

748,121. ELECTRIC ARC LAMP; Knut Tornberg, Medford, Mass. App. filed Nov. 1, 1902. The carbons arranged at right angles to each other are fed between two sets of grooved rollers which are driven by gearing.

748,123. ELECTRIC SWITCH; Isaac G. Waterman, Santa Barbara, Cal. App. filed Feb. 27, 1902. Details.

748,144. REGULATING DEVICE FOR ELECTRIC CIRCUITS; Malcolm H. Baker, East Liberty, Pa. App. filed June 26, 1902. A regulating reactance device having a regulating coil capable of relative inductive movement with respect to a magnetic core and an auxiliary coil, the two coils being arranged in series and being electrically opposed to each other.

748,145. METHOD OF REGULATING ELECTRIC CIRCUITS; Malcolm H. Baker, East Liberty, Pa. App. filed June 26, 1902. The method involved in the preceding apparatus patent.

748,146. CONSTANT POWER FACTOR REGULATING FOR ELECTRIC CIRCUITS; Malcolm H. Baker, East Liberty, Pa. App. filed June 28, 1902. A modification of the two preceding inventions.

748,147. METHOD OF REGULATING ELECTRIC CIRCUITS; Malcolm H. Baker, East Liberty, Pa. App. filed June 28, 1902. Same.

748,148. CUT-OUT FOR ARC LAMPS; Malcolm H. Baker, Pittsburg, Pa. App. filed Oct. 30, 1902. The points of a cut-out are held apart by a pin which rests upon a fusible material, the latter being melted when the carbon has burned away.

748,149. REGULATING DEVICE FOR ELECTRIC CIRCUITS; Malcolm H. Baker, New York, N. Y. App. filed Dec. 8, 1902. The circuit is controlled electrically by means of two coils, one of which is movable with relation to the other, both windings standing in inductive relation to a suitable core and one being connected with a special core forming a magnetic continuation of the first named core.

748,182. MAGNETIC POWER MECHANISM; Frederick Hachmann, St. Paul, Minn. App. filed May 8, 1903. Motion is obtained in a power apparatus by utilizing the difference in the forces required to move an armature laterally out of a field of force and axially or in a parallel direction therefrom.

748,185. ELECTRIC ARC LAMP FOR MULTIPLE OR PARALLEL CIRCUITS; Robert H. Henderson, Newark, N. J. App. filed March 30, 1903. A reactance device in series with the electrodes, having a floating core operating against a counterweight to keep the electrodes together when the lamp is not burning and to bring them together when the terminal arc voltage becomes too high in the normal operation of the lamp.

748,240. BEARING THERMOSTAT; George A. Wall, Providence, R. I. App. filed Oct. 28, 1902. The casing is attached to a shaft bearing and contains a circuit closer held open under tension by fusible material.

748,268. MAGNETIC CONTACT BOX FOR ELECTRIC TRAMWAYS; Alfredo Diatto, Turin, Italy. App. filed April 8, 1902. When the contact in the box is moved, a magnetic field is established and Foucault currents opposing the movements of the field are at the same time created with an object of preventing the formation of an arc between the various parts of the apparatus.

748,306. RECEIVER; Frank E. Peters, Fort Washington, Md. App. filed May 2, 1903. The particles of a coherer are constantly rotated between the poles of a magnet which at the same time serve as the terminals of the aerial circuit.

748,309. ELECTRIC HEATING PAD; William Richards, Los Angeles, Cal. App. filed July 2, 1902. A resistance wire interwoven with the threads of a blanket and connected with plugs for attachment to a circuit.

748,322. TROLLEY DEVICE; Ralph P. Tisch and Robert Kissinger, Hebron, Ohio. App. filed May 23, 1903. The wheel turns on cone bearings having threaded shanks by which they can be set up to compensate for the wear.

748,323. THERMOSTAT; Geo. A. Wall, Providence, R. I. App. filed Oct. 28, 1902. Details.

748,337. SOCKET FOR INCANDESCENT ELECTRIC LAMPS; Charles Blakeley, Covington, Ky. App. filed June 18, 1903. Details.

748,338. SOCKET FOR INCANDESCENT ELECTRIC LAMPS; Charles Blakeley, Covington, Ky. App. filed June 18, 1903. Details.

748,354. AUTOMATIC CONTROLLER FOR ELECTRIC PUMPS OR THE LIKE; Charles H. Durning, Swissvale, Pa. App. filed Jan. 26, 1903. The motor switch is controlled by a differentially wound magnet.

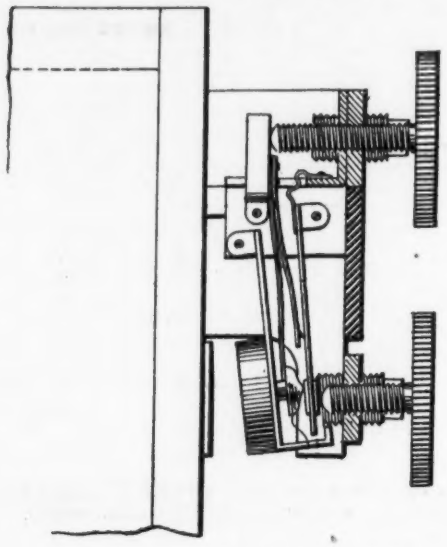
748,360. IGNITING DEVICE; William Gardner, Brooklyn, N. Y. App. filed Sept. 27, 1902. A box containing a battery, an induction coil and a metallic torch conveniently put up for cigar lighting purposes.

748,397. CIRCUIT CHANGING APPARATUS; William Meyer, Chicago, Ill. App. filed Oct. 10, 1901. Improvements in a telephone key-switch.

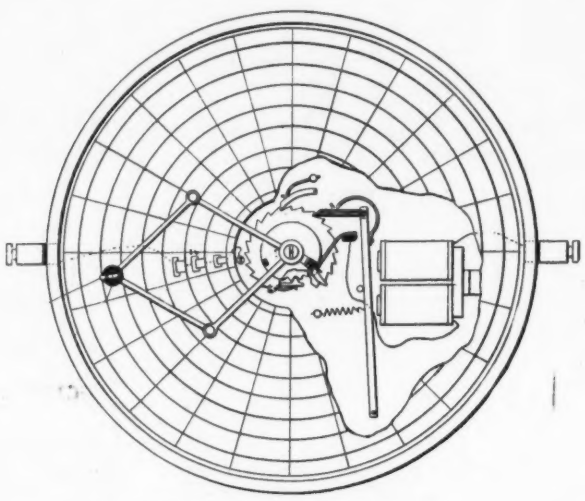
748,408. ELEVATOR SIGNALING APPARATUS; John McLean, New York, N. Y. App. filed Nov. 16, 1901. The indicators in the car are restored automatically as the car passes the landing to which they correspond.

748,409. ELEVATOR SIGNALING APPARATUS; John McLean, New York, N. Y. App. filed Dec. 8, 1902. The elevator attendant can send a return signal to the floor from which a call signal is sent, to indicate to an intending passenger which car will first arrive at the floor traveling in the direction in which the passenger intends to travel.

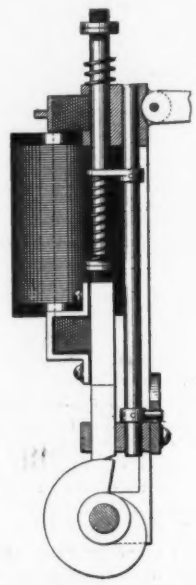
748,422. TROLLEY; Walter J. Rowley, Allegheny, Pa. App. filed May 7, 1903. Opening and closing levers to entrap the wire within the groove of the wheel.



748,442.—Vibrator for Induction Coils.



748,502.—Electric Signaling Apparatus.



748,534.—Electric Generator for Intermittent Currents.

748,441. TROLLEY; Thomas F. Varley, Lowellville, Ohio. App. filed Aug. 14, 1903. Pivoted guards to retain the wire are counterweighted to yield when they strike an obstruction.

748,442. VIBRATOR FOR INDUCTION COILS; Richard Varley, Providence, R. I. App. filed Nov. 6, 1903. In this vibrator the armature is put under motion by the attraction of the coil and then strikes a hammer blow against a circuit controlling lever to give a quick break of the circuit; on the return stroke of the armature, the circuit closing lever is pressed into intimate contact with the end of the contact screw.

748,445. INCANDESCENT LAMP SOCKET; Charles Wagner, Brooklyn, N. Y. App. filed May 2, 1902. A porcelain block having a lamp socket in one end and a axial metallic plug into which side openings lead for the attachment of wires to avoid external metallic parts.

748,450. BLOCK SIGNAL SYSTEM; Elmer E. Wolf and James B. Williams, Springfield, Ohio. App. filed June 20, 1902. Details.

748,451. RAILWAY CROSSING SIGNAL; Elmer E. Wolf and James B. Williams, Springfield, Ohio. App. filed June 20, 1902. In case a train reverses its direction just before it passes the crossing, the signal is rendered inoperative automatically.

748,488. CONTROLLING SYSTEM FOR CONVEYERS; Arthur C. Eastwood, Cleveland, Ohio. App. filed Oct. 16, 1903. Automatic devices for controlling the movements of cars that convey material to the top of blast furnaces.

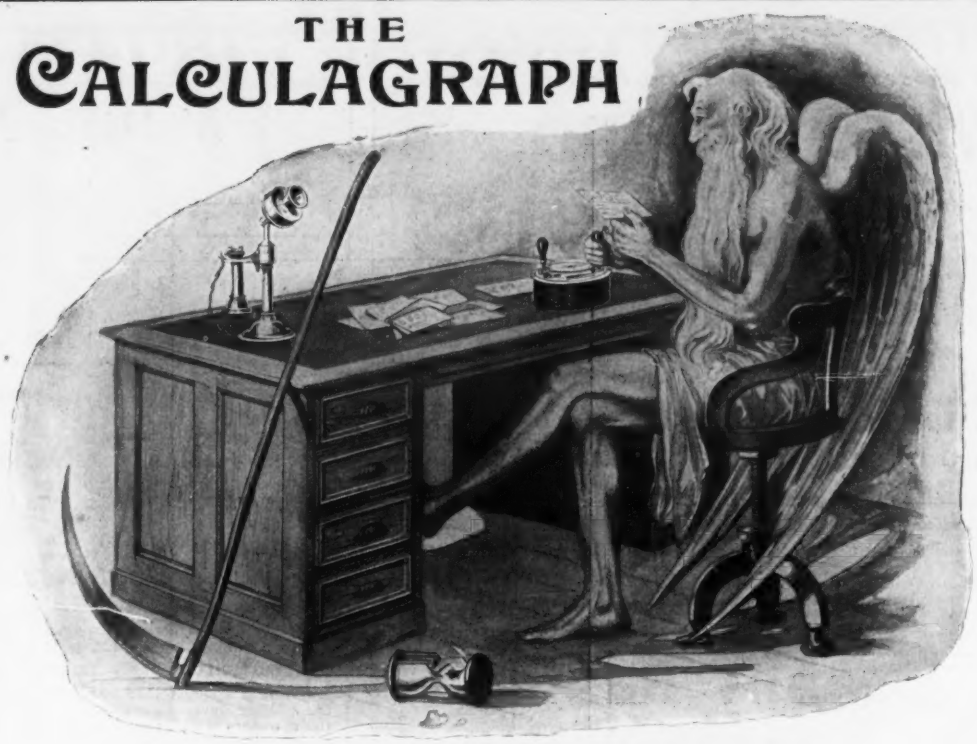
748,501. ELECTRIC SIGNALING APPARATUS; Felix B. Herzog and Schuyler S. Wheeler, New York, N. Y. App. filed Jan. 25, 1886. The index of a transmitter is constructed to move either radially or in a circle over the face of a circular dial and the receiving index partakes of the same movements.

748,502. ELECTRIC SIGNALING APPARATUS; Felix B. Herzog and Schuyler S. Wheeler, New York, N. Y. App. filed Jan. 25, 1886. A modification of the preceding invention.

748,534. ELECTRIC GENERATOR FOR INTERMITTENT CURRENTS; Malcolm P. Ryder, White Plains, N. Y. App. filed March 11, 1903. An armature is lifted into a field by the slow movement of a cam and is suddenly released to impart a quick motion which generates sufficient current to supply a spark.

748,557. ELECTRICALLY CONTROLLED RAILWAY SWITCH; Frederick T. Kitt, Denver, Colo. App. filed March 4, 1903. Details.

THE
CALCULAGRAPH



IT·MAKES·NO "CLERICAL ERRORS"

SEND FOR BOOKLET

Father Time approves and adopts it.

So also have others

* * * If any manufacturer could be assured of the results which we have obtained in several instances by the particular way in which we use the Calculagraph, he could not hesitate in deciding to install an instrument in every branch of his work where the scheme could be used. In at least one instance in our factory, the price of the clock is saved once a month simply because by its use we do away with the operative workman having anything whatever to do with his own time keeping.

Very truly yours,
THE OHIO BRASS CO.

H. C. Schwable

Manager of Cost Dept.
MANSFIELD, OHIO, 6-18-'03.

Calculagraph Company

13 Maiden Lane, NEW YORK, U. S. A.

AGENT FOR GREAT BRITAIN:
J. J. Stockall & Sons, Ltd., 6-8-10 Clerkenwell Road, London, E. C., England.

AGENT FOR CANADA:
Northern Electric & Mfg. Co., Ltd., 1760 Notre Dame St., Montreal.

THE

American Bell Telephone Company,

125 Milk Street, Boston, Mass.

FRANK B. COOK

CABLE TERMINALS

AND

TELEPHONE PROTECTIVE APPARATUS

of my well known standard types, for both Central Office and Subscribers' Stations. Over 500,000 in use. Covered by U. S. Letters Patents.

240-244 West Lake St., - Chicago, U. S. A.

Write for Catalogue Correspondence solicited.

No. 4351

1000 DESK STANDS

Made and Sold Every Month

THEY MUST BE GOOD

. . . WE MAKE . . .

ALL KINDS OF TELEPHONES
ALL KINDS OF SWITCHBOARDS

American Electric Telephone Co.
CHICAGO.

If you don't give your subscribers

Automatic Telephone Service

you don't give them the best.

Write for our catalogue.

Automatic Electric Company

Chicago, U. S. A.

THE INTERNATIONAL
New Type Self-Restoring Drop

SWITCHBOARD.

Ask for sample drop and quotations. Cost nothing to convince yourself that it is

A PERFECT APPARATUS.

Made in any desired capacity.

INTERNATIONAL TELEPHONE M'F'G. CO.
CHICAGO, ILLINOIS.

"The Memory of Quality Lasts Long after Price has been forgetten."

We Have

Many Designs

of Telephones
AND
Switchboards

The NORTH ELECTRIC CO.
CLEVELAND, OHIO
147-157 St. Clair St. C N 157

Telephone Service IS THE Quickest Messenger

RATES IN MANHATTAN

Residence from $4 a month **Business from $5 a month**
One Year Contracts **Monthly Payments**

NEW YORK TELEPHONE CO.
15 Dey Street 111 West 38th Street 220 West 124th Street

1904

NEW IDEAS in Electrical Construction

1903
"Ring out the Old"
1904
"Ring (up) the New"

Wishing that the **New Year** may prove **PROSPEROUS and SATISFACTORY** for the **Electrical Profession and Trade** we respectfully invite their attention to our

DIVIDEND INCREASING SPECIALTIES

which after exhaustive tests and adoption are now in use by many of the **Largest Electrical Operating Co.s** and would suggest that our present and prospective customers favor us with their orders as far as possible in advance of their needs that we may continue prompt deliveries. Illustrated and Descriptive Price List mailed upon request. Order it

NOW

C. L. Peirce, Jr.
Manufacturer of Electrical Construction Material
12-14 South Jefferson St., CHICAGO

MONOPLEX TELEPHONES $2.50 EACH.
Also a Trade Discount.

Monoplex Telephones are the simplest and most reliable instruments now on the market. Thousands are in use, giving perfect service They are guaranteed for one year.

Intercommunicating Instruments
Desk Instruments, $4.00 per station
2 end Instruments 6.00 " "
2.50 per end.

Atwater Kent Mfg. Co., 120 N. 6th St., Philadelphia.

Telephone Transmitter Arms

W. J. BARR MFG. CO.,
CLEVELAND.

Write for our Catalogue of Electrical Books

This is our Junior Type Class C Instrument

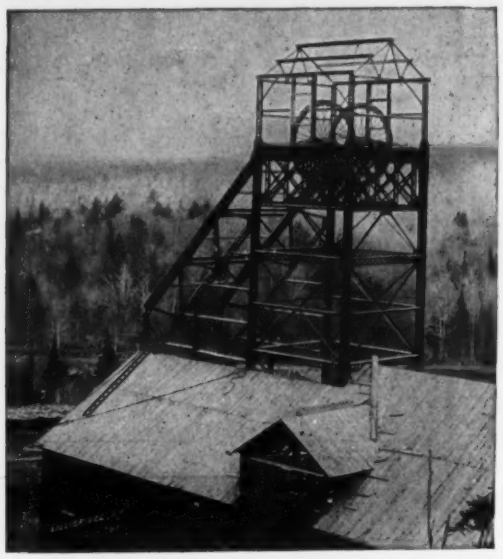
Price f. o. b. factory $50.00

Write us for anything pertaining to wireless telegraph apparatus and supplies.

We Manufacture Wireless Apparatus, comprising parts and complete outfits.

MADE ON HONOR. SOLD ON MERIT.

THOS. E. CLARK WIRELESS TELEGRAPH-TELEPHONE CO.
Detroit Office, 309 Stevens Bldg., corner Grand River and Washington Aves. **Factory, Pontiac, Mich.**



Rock and Shaft House No. 3, Adventure Consolidated Copper Co. at Greenland, Mich.

AMERICAN BRIDGE COMPANY OF NEW YORK

Eastern District
100 Broadway
New York City

Pittsburg Dist.
Frick Building
Pittsburg, Pa.

Western District
1315 Monadnock Block, Chicago

Engineers and Contractors

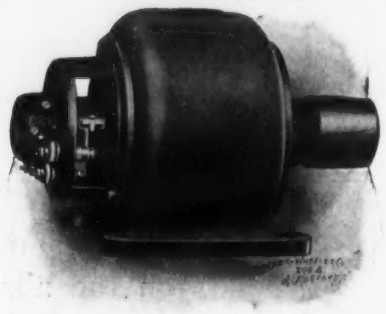
Structural Steel

for

Every Purpose

Small Motors

for the economical drive of small machines



Crocker-Wheeler Company

Manufacturers and Electrical Engineers

Ampere, N. J.

Branch Offices in all Large Cities

FEDERAL ELECTRIC CO., ERIE, PA.

Manufacturers of

GENERATORS, MOTORS, AUTOMATIC CONTROLLERS, DIRECT CONNECTED MINE PUMPS.

WRITE FOR OUR CATALOGUE OF **ELECTRICAL BOOKS**

A TRIUMPH

over every obstacle in *automatic* telephony for

Small Town Exchanges and Intercommunication in Offices, Factories, Shops, Mills, Warehouses, Steamships, Plantations, Hospitals and Public Buildings has been accomplished by

THE CLARK AUTOMATIC TELEPHONE SYSTEM!

We have produced a simple, durable system in which you have only to turn the dial and ring the bell to effect a connection

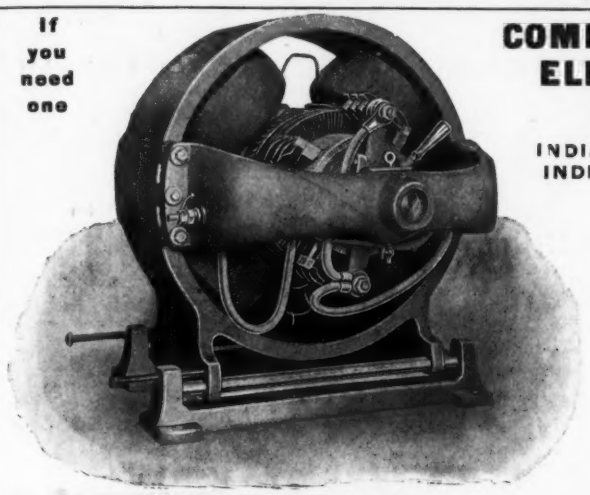
Send for Catalogue "C"

CLARK AUTOMATIC TELEPHONE SWITCHBOARD COMPANY

PROVIDENCE, R. I.

(4)

If you need one



COMMERCIAL ELECTRIC CO.

INDIANAPOLIS, INDIANA U. S. A.

Can furnish the machine and if you wish quality proof **6000** users will tell you they are the best.

Bulletin 330

Standard motors and generators

The best features in any motors are found in

Hobart Motors

REMEMBER their efficiency saves money. Their simplicity saves trouble.

THE HOBART ELECTRIC MFG. CO.
Troy, Ohio.

DYNAMOS and MOTORS

that possess all the essential points for increased life and satisfactory operation.

THE NEW ENGLAND MOTOR CO.

LOWELL. MASS.

WHEN WRITING TO ADVERTISERS PLEASE MENTION
ELECTRICAL WORLD AND ENGINEER.

PSYCHOLOGY AND ADVERTISING.

Walter Dill Scott, Ph.D., Director of the Psychological Section of the Northwestern University, who has made a scientific study of commercial publicity, is the author of a book just published, entitled "The Theory of Advertising." Among other principles laid down are the following:

> "The power of any object to force itself into our attention depends on the absence of counter attractions."
>
> "The power which any object has to attract our attention (or its attention value) depends on the ease with which we are able to comprehend it."
>
> "The attention value of an object depends on the number of times it comes before us, or on repetition."

The first axiom makes it evident that the most forceful advertisement is one which appears in such form that no other advertisement is visible to detract from it; (a double page, for instance).

The second one emphasizes the necessity for making an advertisement clear, concise, to the point.

The third reiterates the well-known, universally-recognized necessity of persistency.

Space large enough to attract the readers' attention, a well-written advertisement and steady presentation of your facts to a well-selected audience *ensures* successful advertising.

ELECTRICAL WORLD AND ENGINEER provides you with the best selected audience in the electrical field, and provides a staff to write your advertisements for you without extra charge. It is published every week and the size of the space you use in it is absolutely in your own hands.

Use large space persistently in

ELECTRICAL WORLD AND ENGINEER

and get business!

YOST

YOST SPECIALTIES

Are of the SUPERIOR SORT

MANY DESIRABLE AND DISTINCTIVE FEATURES

We want you to have our complete catalogue Please ask for it

The Yost Electric Mfg. Co.

TOLEDO, OHIO
U. S. A.

YOST

ALPHABETICAL INDEX TO ADVERTISERS.

Adams-Bagnall Elec. Co. 72
Aitchison Perforated Metal Co., Robert 64
Akron Elec. Mfg. Co. 75
Alberger Condenser Co. 51
Allen Co., L. B. 77
Allis-Chalmers Co. 84
Alphaduct Mfg. Co. 51
American Battery Co. 59
American Bell Telephone Co. 74
American Bridge Co. 1
American Circular Loom Co. 12
American Conduit Co. 76
American Diesel Engine Co. 76
American District Steam Co. 76
American Electric Fuse Co. 59
American Electric Telephone Co. 40
American Electrical Heater Co. 42
American Electrical Mfg. Co. 2
American Electrical Works. 81
American Engine Co. 72
American Insulating Machinery Co. 2
American Platinum Works. 32
American Reflector & Lighting Co. 11
American School of Correspondence. 9
American Steel & Wire Co. 12
American Stone Conduit Co. 1
American Transformer Co. 13
American Vitrified Conduit Co. 17
American Watchman's Time Detector Co. 84
Anderson Mfg. Co., A. & J. M. 32
Anyun Lamp & Elec. Co. 36
Applied Device Co. 56
Archer, Geo. F. 56
Arnold Electric Power Station Co. 51
Associated Engineering Co. 58
Atlantic Insulated Wire & Cable Co. 71
Atwater Kent Mfg. Co. 58
Aultman Company 74
Automatic Elec. Co. 84

Babcock & Wilcox Co. 3
Baillard, E. V. 56
Baker & Co. 79
Baker & Co., W. E. 81
Ball & Wood Co. 17
Ball Engine Co. 72
Banner Elec. Co. 84
Barnes Co., The Wallace. 51
Barnes Co., W. F. & John. 56
Barnett Co., G. & H. 10
Barr Mfg. Co., W. J. 12
Barstow, W. S. 78
Bates & Bros., D. L. 55
Bates Machine Co. 1
Bay State Stamping Co. 8
Beardsworth Eng. & Mach. Co. 53
Becker Eng. Co., A. 25
Bellevue Porcelain Works. 3
Bender, Geo. 19
Benjamin Elec. Mfg. Co. 65
Biddle, James G. 63
Bissell Co., F. 56
Bogue, Chas. J. 3
Bossert Electric Const. Co. 56
Brady, T. H. 23
Bridgeport Brass Co. 14
Brilliant Elec. Co. 1
Bristol Co. 21
Brown, C. L. 1
Browning Co. 56
Bullock Electric Mfg. Co. 65
Burch, Edward P. 63
Burt Mfg. Co. 56
Byllesby & Co., H. M. 3
Byrnes & Townsend. 56

C. & C. Electric Co. 62
Calculagraph Co. 59
Caldwell, Edward 55
Calman & Co., Emil. 2
Camp Co., H. B. 13
Carlisle & Finch Co. 34
Carman & Co., Chas. Whitney. 56
Carpenter Tap & Die Co., J. M. 72
Cary Spring Works. 17
Case Mfg. Co. 24
C., C., C. & St. L. Ry. 54
Central Electric Co. 2
Central Tel. & Elec. Co. 64
Century Electric Co. 56
Chapman, Chas. A. 20
Chase-Shawmut Co. 56
Chicago Edison Co. 14
Chicago & Alton Railway. 8
Chicago & Northwestern Ry. 46
Chicago Fuse Wire & Mfg. Co. 75
Chicago Insulated Wire Co. 14
Christensen, N. A. 62
Cincinnati Tool Co. 60
Clark Automatic Telephone S. B. Co. 58
Clark Wireless Telegraph & Telephone Co., Thos. E. 56
Coho & Co., H. B. 61
Collins, A. Frederick. 21
Columbia Inc. Lamp Co. 8
Columbus Storage Battery Co. 56
Compressed Fibre Co. 61
Commercial Elec. Co. ..... 75 & 78
Conn. Tel. & Elec. Co. 3
Conover Mfg. Co. 84
Consolidated Railway, Elec. Lighting & Equipment Co. 23
Consumers' Carbon Co. 55
Cook, F. B. 2
Cope, T. J. 75
Copenhagen Auto Fire Alarm Co. 78
Corson, Wm. R. C. 4
Couch, S. H. 11
Crane Co. 54
Crescent Co. 25
Crescent Insulated Wire & Cable Co. 64
Crocker-Wheeler Co. 15
Crosby Steam Gage & Valve Co. 1
Croselmire & Ackor. 2
Crouse-Hinds Co. 4
Crowe Metal Mfg. Co. 51
Cutler-Hammer Mfg. Co. 58
Cutter Elec. & Mfg. Co. 74

D. & W. Fuse Co. 84
Dayton Fan & Motor Co. 3
Dearborn Drug & Chemical Works. 56
Delaware Hard Fibre Co. 79
Diamond Meter Co. 81
Diehl Mfg. Co. 72
Dielectric Mfg. Co. 84
Directory of Engineers. 51
Dixon Crucible Co., Jos. 56
Doble, Robert McF. 6
Dongan Instrument Co. 38
Doubleday-Hill Electric Co. 14
Downward Light Elec. Co. 16
Dunbar Bros. 30
Duncan Electric Mfg. Co. 16
Dyer & Dyer. 14

Eastern Arm and Pin Co. 14
Eastern Carbon Works 62
Eccleston Lumber Co. 33
Eck Dynamo & Motor Works 46
Economical Electric Lamp Co. 29
Edison Dec. & Min. Lamp Dept. 24
Edison Mfg. Co. 51
Edwards & Co. 3
Electric Appliance Co. 70
Electric Contract Co. 3
Electric Controller & Supply Co. 43
Electric Cotton-Leather Belting Co. 20
Electric Launch Co. 14
Electric Machinery Co. 40
Electric Motor and Equipment Co. 28
Electric Storage Battery Co. 21
Electrical Engineers Inst. of Cor. Inst. 54
Electrical Equipment & Supply Co. 64
Electrical Specialty Co. 22
Electrical World and Engineer 46
Electro-Dynamic Co. 10
Elliott Bros. Elec. Co. 7
Elwell-Parker Electric Co. 60
Emerson Elec. Mfg. Co. 46
Empire China Works 56
Empire Elec'l Instrument Co. 39
Engineers, Directory of 60
Engineering Record 56
Ewing-Merkle Co. 80

Fahnestock Transmitter Co. 46
Federal Elec. Co. 65
Federal Elec. Co. 7
Foote, Pierson & Co. 56
Ford, Bacon & Davis 56
Foster, Horatio A. 41
Ft. Wayne Electric Works 37
Frick Co. 31
Frink, I. P. 78
Frorup, L. E. 38
Fuller Co. 7

Garton-Daniels Co. 56
General Electric Co. 56
General Engineering Co. 33
General Inc. Arc Lt. Co. 31
Germania Elec. Lamp Co. 21
Gest, G. M. 17
Globe Electric Controller Co. 51
Goepel & Niles 3
Goudey-McLean Co. 75
Gould Storage Battery Co. ..... 52 and 53
Green Fuel Economizer Co. 19
Gregory Electric Co. 46

H. O. S. Eng'g Co. 65
Haas Elec. & Mfg. Co., R. 7
Haller Machine Co. 56
Hamerschlag Cons. Co. 56
Hanchett, Geo. T. 41
Hardinge Bros. 38
Harrisburg Foundry & Mach. Wks. 7
Hart Mfg. Co. 56
Hart & Co., Inc. 56
Hartford Faience Co. 56
Hartford Time Switch Co. 56
Hatch Accumulator Co. 56
Hazard Mfg. Co. 56
Heck, Louis 56
Heine Safety Boiler Co. 56
Hemingray Glass Co. 56
Hertner Electric Co. 56
Hill Brass Co., N. N. 56
Hill Elec. Co., W. S. 56
Hobart Elec. Mfg. Co. 56
Hoffman, George W. 56
Holophane Glass Co. 56
Holtzer-Cabot Elec. Co. 56
Horry, Wm. Smith 56
Hubbard's Sons, Norman 56
Humphreys, Henry H. 56
Hunt Co., C. W. 56
Hunter Fan & Motor Co. 56
Hunter Machine Co., James 56
Hutton Engineering Co. 56

Ide & Sons, A. L. 56
Incandescent Elec. Lt. Manip. Co. 56
India Rubber & G. P. Ins. Co. 56
Indiana Rubber & Ins. Wire Co. 56
Int. Brass & Elec. Co. 56
Int. Correspondence Schools 56
Int. Telph. Mfg. Co. 56
Iron City Engineering Co. 56

Jackson, Dugald C. 56
Jackson, Wm. B. 56
J-E-M Shade Holder Co. 56
Jaeger Miniature Lamp Mfg. Co. 56
Jeffrey Mfg. Co. 56
Jenkins Bros. 56
Jenny Elec. Mfg. Co. 56
Jewell Electrical Inst. Co. 56
Johns-Mansville Co., H. W. 56
Johnson & Morton 56
Johnston, Thomas J. 56
Jones & Son, J. 56
Jordan Bros. 56

K. & W. Co. 56
Kartavert Mfg. Co. 56
Kellogg & Co., E. H. 56
Kellogg Switchboard & Sup. Co. 56
Kelly Engineering Co., John F. 56
Keystone Elec. Inst. Co. 56
Keystone Electric Co. 56
Kilbourne & Clark Co. 56
Kinsman Elec. & Ry. Supply Co. 56
Klein & Sons, Mathias 56

Kleigl Bros. 56
Klipstein & Co., A. 56
Kohler Bros. 56
Kreusi, P. J. 56

Lakon Co. 56
Lamp Testing Bureau 56
Lansingh, Van Rennselaer 56
Lanyon Zinc Co. 56
La Roche Co., F. A. 56
Leclanche Battery Co. 56
Leeds & Northrup Co. 56
Leffel & Co., James 56
Leslie & Co., A. C. 56
Lincoln Elec. Co. 56
Le Valley Vitæ Carbon Brush Co. 56
Lippincott Glass Co. 56
Link-Belt Engineering Co. 56
Locke Insulator Mfg. Co. 56
Lombard Governor Co. 56
Lowell Model Co. 56
Lunkenheimer Co. 56

McCullough-Dalzell Crucible Co. 56
McGill University 56
McGowan & Co., John H. 56
McIntosh, Seymour & Co. 56
McLennan & Co., K. 56
McLeod, Ward & Co. 56
Machado & Roller. 56
Magnet Wire Co. 56
Mailloux, C. O. 56
Manhattan Dial Co. 56
Manhattan Electrical Supply Co. 56
Manross, F. N. 56
Maris Bros. 56
Marshall, William 56
Masson, R. S. 56
Maxfield, T. C. 56
Mead Mfg. Co., J. A. 56
Mechanical Appliance Co. 56
Meyrowitz, E. B. 56
Mica Insulator Co. 56
Michigan College of Mines. 56
Mietz, A. 56
Milwaukee Electric Co. 56
Minneapolis Steel & Mchy. Co. 56
Missouri American Elec. Co. 56
Moloney Elec. Co. 56
Monson Burmah Slate Co. 56
Montauk Fire Detecting Wire Co. 56
Moore, A. F. 56
Morse Twist Drill & Mach. Co. 56
Munder Electric Co. 56
Munroe, Hall & Hopkins. 56
Munsell & Co., Eugene. 56
Muralt & Co. 56
Mustard, John 56

Narragansett Mach. Co. 56
National Battery Co. 56
National Conduit & Cable Co. 56
National Electric Co. 56
National Electric Signalling Co. 56
National India Rubber Co. 56
National Wire Corporation. 56
National X-Ray Reflector Co. 56
Nernst Lamp Co. 56
New England Motor Co. 56
New Process Rawhide Co. 56
New York & Ohio Co. 56
New York Central R. R. 56
New York Insulated Wire Co. 56
New York Safety Steam Power Co. 56
New York Telephone Co. 56
Niles-Bement-Pond Co. 56
North Electric Mfg. Co. 56
Northern Electric Mfg. Co. 56
Northern Eng'g Works. 56
Northwestern Electric Co. 56

Ohio National Mfg. Co. 56
Okonite Co., Ltd. 56
Osburn Flexible Conduit Co. 56
Ostrander, W. M. 56
Ostrander & Co., W. R. 56
Otto Gas Engine Works. 56

Paiste Co., H. T. 56
Palmer, W. K. 56

Continued on Page 38.

THE ELECTROGRIP

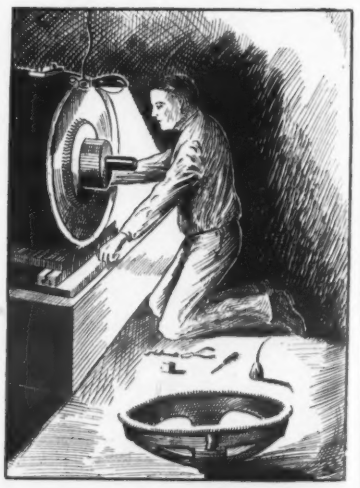
The Best Device and most convenient for holding an electric lamp in "difficult-to-get-at" places. Secures the light just where you want it

By pressing the arms to the centre, the jaws open to any desired width; slip the jaws on either side of the supporting device and let go; the spring holds the lamp rigid and secure. It enables the lamp to be placed in any position.

Special prices to supply houses

THE APPLIED DEVICE CO.

SPRINGFIELD, MASS.



LOCKE "VICTOR" TYPE INSULATORS

Send for Catalogue No. 6.

Five Million in Daily Use

Patented Sept. 28, 1897; June 7, 1899: and May 29, 1900.

Other patents now pending.

No. 329 Insulator, the highest Voltage Insulator in the world for 60,000 to 80,000 volts; tested at 125,000 volts.

Locke Insulators are made for any Voltage up to

150,000 VOLTS

Adopted by the

Bay Counties Power Co.
Standard Elec Co. of Cal.
Seattle, Tacoma and Interurban R'y Co.
Guanajuato Power and Electric Co
Washington Water Power Co.
for the

Longest and Highest Voltage lines in the World

THE LOCKE INSULATOR MFG. CO.,

VICTOR, N. Y., U. S. A.

JNO. MARTIN & CO. { 33 New Montgomery St., San Francisco, Cal
507 Pioneer Building, Seattle, Wash.
511 Douglass Block, Los Angeles, Cal.

WM. E. PECK & CO., 116 Broad St., New York; Australia, Mexico.
GUIDO TOLUSSO, Via Torino 61, Milan, Italy.

ELECTRICAL WORLD AND ENGINEER

Is more widely quoted abroad than any other Electrical Journal published

"THE FRINK STANDARD" SHADES

Lined with Opal, Best Mirror or Frink's Silvered Corrugated Glass

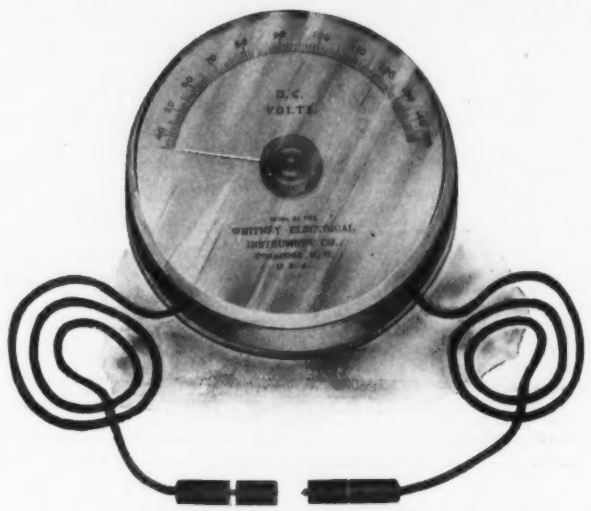
Made in Convex, Concave or Flat Shapes, and in ten diameters

Made to reflect ALL, not a part of the Light

Send for catalogue of all kinds of reflectors for electric lighting.

I. P. FRINK, 551 Pearl Street, New York

C.P. (COAT POCKET) TYPE INSTRUMENTS



List Price this Range, $16.00.

A NEW LINE READY FEB. 1ST, 1904

It comprises voltmeters of ranges from 3 to 300 volts and ammeters of from 1 to 25 amperes. Diameter of all sizes, 4 inches; thickness, 1⅜ inches. The leads and terminals can be laid away in a compartment in the rear of the case.

Just fits the coat pocket

Send for discounts to

MACHADO & ROLLER

203 BROADWAY NEW YORK, N. Y.

Or your nearest supply house

EMPIRE CLOTH AND PAPER

A high grade Insulator, composed of specially woven fabrics and prepared papers, treated with pure linseed oil and thoroughly baked; average puncture voltage 650 volts per mil of thickness.

MICA INSULATOR COMPANY

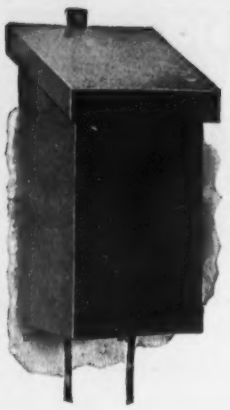
CHICAGO ORIGINATORS NEW YORK

BOOKS

ON ANY ELECTRICAL SUBJECT sent, prepaid, to any address in the world, upon receipt of price.

SEND FOR CATALOGUE.

Book Department McGRAW PUBLISHING COMPANY, 114 Liberty St., New York City.



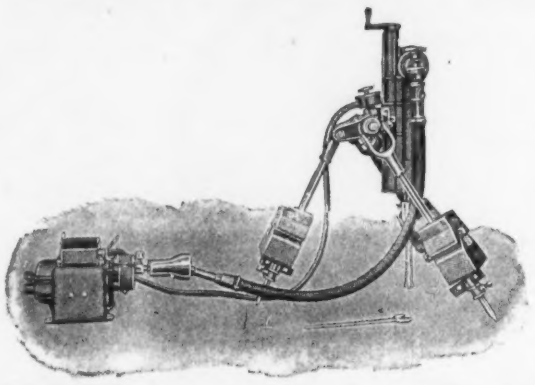
THE MORE OUTLETS for the discharge, the less Lightning will reach your station.

GARTON LIGHTNING ARRESTERS

constitute outlets of the lowest possible resistance to the discharge—due to small air-gap, low ohmic resistance, etc. These facts are demonstrated in actual service. Our Catalogue tells how. Ask your supply house, or

GARTON-DANIELS COMPANY, Keokuk, Iowa, U. S. A. (5)

GARDNER ELECTRIC ROCK DRILL



SAVES 80% IN FUEL COST
SAVES 25% IN FIRST COST
SAVES 75% IN ERECTION COST

SOLE REPRESENTATIVES

Doubleday-Hill Electric Co.

Manufacturers and Dealers ELECTRICAL SUPPLIES

PITTSBURG, PA.

HIGHEST GRADE, LOWEST PRICES, QUICKEST DELIVERIES

ALPHABETICAL INDEX TO ADVERTISERS.—*Continued from Page 36.*

Parsell & Weed 84
Pass & Seymour, Inc 17
Patterson, H. C 57
Pawling & Harnischfeger 71
Peirce, C. L., Jr 58
Peerless Rubber Mfg. Co 75
Pelton Water Wheel Co 45
Pepper & Register 57
Phelan, D. W 14
Phœnix Glass Co 1
Phosphor Bronze Smelting Co 78
Pierce, Richardson & Neiler 57
Pignolet, Louis M 6
Pittsburg Sewer Pipe & Conduit Co .. 12
Porter Cedar Co 14
Portland Co. .....
Power & Mining Machinery Co 76
Power Installation Co 57
Pratt, Chas. F 57
Pratt & Atkins 57
Pratt & Whitney Co ..... .
Prometheus Electric Co 21
Proposals .....54 and 55
Providence Engineering Works .....
Pulsometer Eng'g Co., Ltd 33

Queen & Co 4
Quimby, Wm. E., Inc ..... .

Reckenzaun, Fred'k 57
Reisinger, Hugo 30
Renim Specialty Co .....
Reynolds Electric Flasher Mfg. Co ...
Ridgway Dyn. & Eng. Co. 79
Richardson Scale Co 72
Robb-Mumford Boiler Co 74
Robbins & Myers Co .....10 & 67
Robins Conveying Belt Co 70
Roche, Wm. 16
Rochester Mach. Tool Wks .....
Rockwood Mfg. Co 73
Roebling's Sons Co., John A 8
Roessler-Hasslacher Chemical Co .....
Rosenbaum, W. A 51
Rosenberg Co., A .....
Rossiter, MacGovern & Co 55
Rotary Engine Co 79
Roth Bros. & Co .....
Rushmore Dynamo Works 44
Russell, Tomlinson Electric Co 61
Ryle & Co., William .....

Safety Insulated Wire & Cable Co .. 9
Samson Cordage Works 46
Sanderson & Porter 57
Sangamo Electric Co .....
Sargent & Lundy 57
Savage & Love 76
Sawyer-Man Electric Co .....
Schaeffer & Budenberg Mfg. Co 75
Schoonmaker, A. O 2
Schoonmaker Co., A. G .....
Schott, W. H 57
Schureman & Co., J. L 24
Scranton Button Co 22
Scranton Steam Pump Co 51
Sears, Henry D 8
Sebastian Lathe Co 72
Seneca Falls Mfg. Co 72
Shain, Chas. D 2
Sheaff & Jaasted 57
Shelby Elec. Co .....26 & 27
Shepherd Engineering Co 78
Shultz Belting Co 1
Signaloid Chemical Works 32
Sills-Eddy Mica Co 8
Simplex Electrical Co 1
Skinner Engine Co 81
Smith Storage Battery Co 18
Smith, Hemenway & Co., Corp 3
Smith Co., S. Morgan 44
Smith, Wm. Lincoln 57
Southwark Foundry & Mach. Co .....
Southworth & Hare 52
Splitdorf, C. F. 2
Sprague Electric Co 13
Standard Elec'l Mfg. Co 32
Standard Paint Co 46
Standard Underground Cable Co .. 84
Stanley Elec. Mfg. Co 41
Stanley Instrument Co 4
Stanton, Le Roy W 57
Station Equipment Co 54
Sterling & Son, W. C 14
Sterling Electric Co 60
Sterling Elec'l Mfg. Co 32
Sterling Varnish Co 46
Stern, Philip K 57
Steward Mfg. Co., D. M 40
Stilwell-Bierce & Smith-Vaile Co .. 45
Storage Battery Supply Co 16
Stow Mfg. Co 70
Straley, Hasbrouck & Schloeder .....
Strock, S. C 14
Stromberg-Carlson Teleph. Mfg. Co . 60
Stuart-Howland Co 7
Sturtevant Co., B. F 62
Sturgess Governor Eng'g Co 44
Sundh Electric Co 24
Sunlight Lava Mfg. Co 51
Swan & Co., Frederick A 32

Thompson-Bonney Co 54
Thompson, Son & Co 53
Tod Co., The William 78
Toerring Co., C. J .....
Townsend & Decker 51
Triumph Elec. Co 63
Trumbull Elec. Mfg. Co 20

United Button Co 22
United Electric Heating Co .....
U. S. Battery Co 84
United Telpherage Co .....
Utica Drop Forge & Tool Co 3

Va. Locust Pin Co 14
Valentine Clark Co 14
Vance, D. T .....
Van Nostrand Co .....
Varley Duplex Magnet Co 51
Viaduct Co 58
Vilter Mfg. Co .....
Vulcanized Fibre Co 9

Wagner, Herbert A 57
Wagner Elec. Mfg. Co 69
Wagor Mfg. Co., P. R 32
Walker Company 22
Want and For Sale Ads .....52 and 55
Ward Leonard Elec. Co. ..17-19-21 and 23
Warner Instrument Co 6
Warner, W. F .....
Warren Elec. Mfg. Co 69
Waterbury & Co 84
Watertown Engine Co 78
Watson-Stillman Co 72
Webster Chemical Co 32
Weiss, W. F .....
Western Display Co 33
Western Electric Co 5
Westinghouse, Church, Kerr & Co ..
Westinghouse Elec. Mfg. Co 83
Westinghouse Machine Co 82
Weston Elect. Inst. Co 6
Wetherill & Co., Robt 78
White & Co., J. G 57
Whitehead Machinery Co 54
Whitted, Thos. B 57
Whitney Elec. Inst. Co 37
Willyoung & Gibson Co 6
Wirt Electric Co 39
Wood & Co., R. D 76
Woodward Governor Co 44
Worcester Co., C. H 14

Yale & Towne Mfg. Co 71
Yost Elec. Mfg. Co 35

Zimdars & Hunt 23

An Intending Purchaser

of Electrical Apparatus anywhere always consults this paper's advertising pages to ascertain who makes what he wants. ELECTRICAL WORLD AND ENGINEER is recognized in every country of the world as the leading electrical journal